A COMPARATIVE STUDY ON PREDICTIVE VALUE OF MALIGNANCY IN SUSPICIOUS BREAST MASSES OF BIRADS III & ABOVE CATEGORIES USING SONOELASTOGRAPHY AND DYNAMIC MR MAMMOGRAM

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MAY 2018

CERTIFICATE

This is to certify that the dissertation **"A COMPARATIVE STUDY ON PREDICTIVE VALUE OF MALIGNANCY IN SUSPICIOUS BREAST MASSES OF BIRADS III & ABOVE CATEGORIES USING SONOELASTOGRAPHY AND DYNAMIC MR MAMMOGRAM"** titled submitted by **Dr.M.ALAMELU** appearing for **M.D(RADIODIAGNOSIS)** degree examination in May 2018 is a bonafide record of work done by her under my guidance and supervision in partial fulfillment of requirement of the Tamilnadu Dr.M.G.R. Medical University, Chennai. I forward this to the TamilNadu Dr.M.G.R Medical University, Chennai.

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DECLARATION

I Dr. M. ALAMELU, solemnly declare that this dissertation **"A COMPARATIVE STUDY ON PREDICTIVE VALUE OF MALIGNANCY IN SUSPICIOUS BREAST MASSES OF BIRADS III & ABOVE CATEGORIES USING SONOELASTOGRAPHY AND DYNAMIC MR MAMMOGRAM"** is a bonafide work done by me at Government Kilpauk Medical College, under the supervision of **Dr.J.DEVIMEENAL DMRD, DNB, MD, FRCR,** Professor, Government Kilpauk Medical College. This dissertation is submitted to the Tamil Nadu Dr. M.G.R Medical University, towards partial fulfillment of requirement for the award of M.D. Degree Radiodiagnosis.

Place: Chennai Signature of the candidate

Date: **Dr. M. ALAMELU**

CERTIFICATE – II

This is to certify that this dissertation work titled entitled dissertation **"A COMPARATIVE STUDY ON PREDICTIVE VALUE OF MALIGNANCY IN SUSPICIOUS BREAST MASSES OF BIRADS III & ABOVE CATEGORIES USING SONOELASTOGRAPHY AND DYNAMIC MR MAMMOGRAM"** of the candidate **Dr. M. ALAMELU** with Registration Number **201518251** for the award of **M.D** degree in the branch of **RADIODIAGNOSIS**. I personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **2%** of plagiarism in this dissertation.

Guide & Supervisor sign with Seal.

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CONTENTS

INTRODUCTION

Breast masses include a wide range of pathologies, that can either be benign or malignant lesions. Among all breast masses, fibroadenoma is the most commonly diagnosed benign breast mass and Invasive Ductal Carcinoma is the most common among the malignant masses [1].

Although most breast masses are benign in nature, carcinoma breast is the most common malignancy in Indian women as reported by Gupta et al [2] in 2016 and is the second leading cause of cancer related deaths in women, which has recently overtaken the mortality rates of cervical malignancies as stated by The **National cancer registry of India.**

India is now a country which has the largest estimated number of breast cancer deaths worldwide. Breast cancer accounts for 27 % of all cancers in women in India, with its incidence rising in the early thirties and peaking at ages between 50-64 years. As for other cancers concerned in India, late stage presentation is also a common scenario for breast cancer [2].

The **BI-RADS** stands for **Breast Imaging-Reporting and Data System**, is being a widely followed risk assessment criteria and quality

assurance tool in mammography, ultrasound (USG) and Magnetic Resonance Imaging (MRI) [3].

BIRADS 1and 2 lesions are clearly benign lesions. BIRADS 3 and 4 categories are intermediate lesions. BIRADS 5 and 6 are malignant.

There are various imaging modalities now available in the breast radiology. Currently, Sonoelastography is an advanced sonographic technique being used in the assessment of suspicious breast masses in complement with the conventional B-mode Ultrasonogram. Sonoelastography quantifies elasticity of the tissues by means of pressure exerted on them.

The lesions are quantified according to the colour scale in Sonoelastogram. Among various scoring methods, the Tsukuba elasticity score is the most known and commonly used scoring systems in elastography.[4]

There is a dramatic progress in the field of breast MRI over the past decade. MRI has exceptionally high sensitivity for the detection of breast cancer and it can aid in depicting cancers that are entirely occult on conventional imaging.

Gadolinium contrast MRI is used to enhance the vascularity of malignant breast lesions. Dynamic MR Mammogram with curve patterns

is recently being used to assess the exact nature of suspicious breast masses.

Many investigators have detailed either enhancement kinetics of the lesion or morphology of the lesion to differentiate benign from malignant mass lesions identified on contrast-enhanced MR imaging studies. But integration of both kinetic and morphologic data is ultimately required to achieve optimal discrimination of pathology.

Breast biopsy is an invasive procedure aimed at confirming the breast lesion detection, remains the gold standard in detection of breast pathologies.

ANATOMY OF BREAST

EMBRYOLOGICAL DEVELOPMENT OF BREAST:

During 6th week of fetal life, primary mammary ridges (milk lines) develops from axilla to medial thigh. In later life, only the mammary ridge in the pectoral region develops into breast. During 12th to 16th week, development of nipple – areolar complex begins. The breast mound increases in size during puberty. Usual location of nipple is at 4th intercostal space.

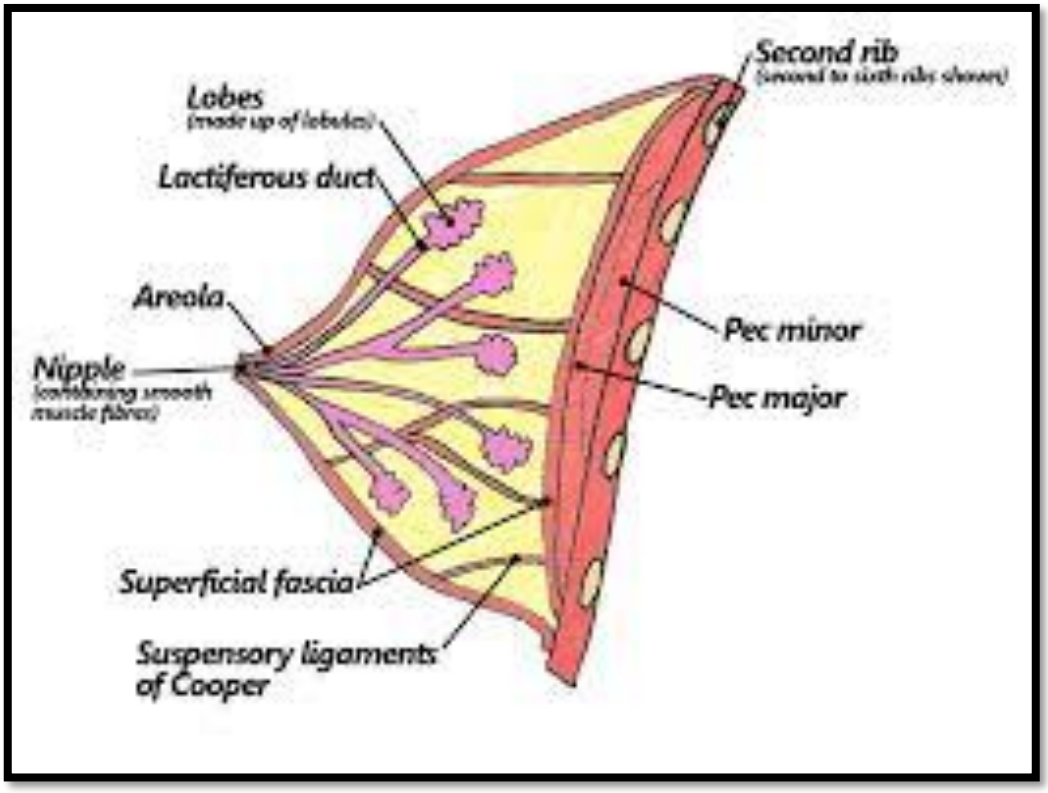
The breast contains adipose tissue and glandular tissue. Breast extends from 2nd to 6th ribs. Normal adult breast has nearly 15 to 20 segments which are demarcated by mammary ducts, converging in a radial fashion at the nipple. The number of mammary segments and mammary ducts vary in size. The average diameter of mammary duct is 2mm, converges into lactiferous sinus of 5 – 8 mm diameter.

Terminal Ductal lobular unit (TDLU):

TDLU are the basic functional as well as the basic histological unit of breast [5]. The size of usual TDLU ranges from 1to 4 mm. The TDLU composed of the extra lobular terminal duct, the intralobular terminal duct, the lobule [6].

The pathologies of TDLU are:

- Ductal Carcinoma In Situ (DCIS)
- Lobular Carcinoma In Situ (LCIS)
- Fibroadenoma
- Fibroadenosis and Apocrine metaplasia of breast
- Breast cysts



The **arterial supply** to breast perforating branches of internal thoracic artery, branches of 3rd to 8th intercostal arteries, thoracoacromial artery, artery to Serratus anterior and lateral thoracic artery.

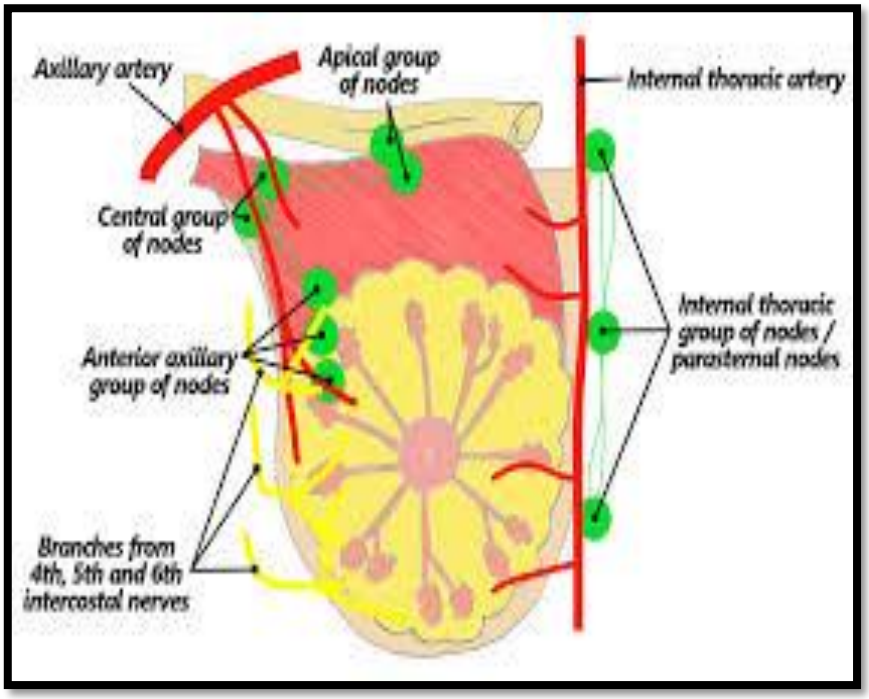
Venous drainage from breast is through axillary vein, internal thoracic and posterior intercostal veins.

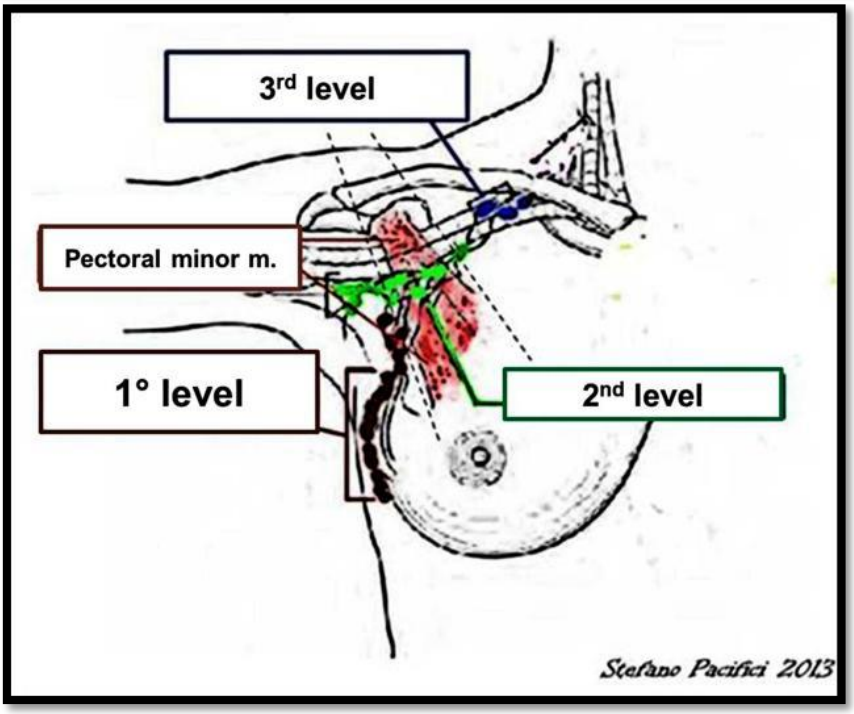
Nerve supply to breast is via thoracic intercostals nerves from T3 – T5 and from supraclavicular nerve.

The lymphatic drainage of breast is via sappey's plexus (subareolar plexus) into three routes [7]:

- Axillary or lateral pathway (predominant drainage)
- Internal mammary pathway
- Retro mammary pathway

Axillary nodes include the following group of lymph nodes: Anterior (pectoral), Lateral (humeral), Posterior (subscapular), Central and Apical (terminal) groups.





Surgical classification of axillary group of nodes is:

- Level 1 – inferior to pectoralis minor muscle
- Level 2 – posterior to pectoralis minor muscle
- Level 3 – medial to pectoralis minor muscle

REVIEW OF LITERATURE

INCIDENCE AND RISK FACTORS OF CARCINOMA BREAST:

An annual incidence of about 1,44,000 new cases of breast cancers are reported in India, it has become now the most common female cancer among urban population. It is been estimated that 1 in 28 Indian women is likely to develop breast cancer during her lifetime. It is seen that Indians have a much lower incidence carcinoma breast than that of western countries, the incidence is- about one-third in urban areas and one-ninth in rural regions of India [8].

Breast cancer incidence in Indian women varies from as low as 5 per 100,000 women per year in rural areas to 30 per 100,000 women per year in urban areas as stated by **National Cancer Registry Programme, ICMR:** A consolidated report based on the hospital registries. There is a wide lack of population screening in Indians on par with corresponding over diagnosis in western population is the contributing factor to this varied statistics.

The etiologies for varying incidence in the breast cancer among rural and urban women cannot be completely studied, which are more likely attributed to the differences in their reproductive and lifestyle factors such as Literacy, Dietary habits, age of menarche and menopause,

age at first child birth, history of abortion, history of intake of oral contraceptives and family history of Breast cancer [9, 10, 11]

Nulliparous women are at two fold higher risk of breast cancer compared to multiparous women [10]. Early menarche less than 12 years) , multiple abortions (more than 2), less duration of breast feeding, and consumption of excess dietary fat (especially animal fat) more than 30 g/day are all highly associated with breast cancer[12].

Women of young age with breast cancer are associated with larger size of the tumor, more number of axillary lymph nodes, high tumour grade, low rates of hormone receptor-positive status, earlier and frequent loco regional recurrences, and poor overall survival rate[13].

Genes associated with increased risk of breast cancer are mainly **BRCA1** (Breast Cancer gene one) and **BRCA2** (BReast CAncer gene two). Other genes related to development of carcinoma breast include **ATM, NBN, CDH1, PTEN, CHEK2, RAD50, RAD51C** and **TP53**.

Women who have no awareness regarding the usual presenting symptoms of breast cancer and women who do lack regular habit of self examination of the breast are at increased risk of developing breast malignancies.

Women with previous history of benign breast masses are also at high risk of developing malignant masses [14].

There exists a huge need of efforts at researching, preserving and propagating the factors which are likely to be associated with the protection of Indian women from developing carcinoma breast.

There are vast number of ongoing **studies & research works** on the incidence and risk factors of developing carcinoma breast among Indians.

Among various studies, the down listed three studies are vital ones.

The first vital study is on assessment of various risk factors of carcinoma breast in Indian population is the case – control study conducted by **Nag et al.,** that aims at evaluation of differential risk factors for triple-negative breast carcinoma (TNBC) compared to Estrogen Receptor-positive breast carcinoma[15]

The second vital study is also a case-control study that is looking forward at risk factors such as weight and body size (waist – hip ratio, BMI) of the affected Indian women patients with carcinoma breast [2].

The third study is a cohort study conducted in the rural region of Maharashtra by **Dikshit et al,** concerning on the conventional and also

germline risk factors of developing carcinoma breast in a longitudinal manner.

There are many research works and studies on the factors that can protect from developing breast carcinoma. The protective factors assessed are women who have completed their first full term pregnancy at younger age (less than 30 years), female who completed more than 3 full term pregnancies. Women with regular breast feeding history had significant protection against the development of cancer breast as stated by **Lai FM et al** [16].

In the non-lactating young women, the breast parenchyma is mainly the fibroglandular tissue, with little or no subcutaneous fat. With increase in the age and parity of the women, increased fat deposition in both the subcutaneous and retromammary zone occurs.

IMAGING OF BREAST MASSES:

The **X-Ray mammogram** is ever the best screening tool available for the detection of breast cancer. Mammography can either be screening or diagnostic. It is a least expensive modality.

Regular mammographic views include Cranio-Caudal view and Medio-Lateral Oblique views. Other supplementary views can be tailored based on patient needs.

In general, bilateral breast mammogram is recommended for all women beginning at the age of 40 years by the **American College of Radiology, American Cancer Society, and American College of Surgeons**. For the women who are with great risk of carcinoma breast development (i.e., those with higher than 20-25% lifetime risk), annual surveillance with MRI is now being recommended [17]. Several researches focus that annual mammograms can aid in early detection of breast cancers, so that breast-conservation therapies are possible.

The overall sensitivity of x-ray mammography in detecting the breast cancer is about 85%. However, in women with dense breast, the sensitivity of mammography is vastly reduced to 47.8-64.4% [18].

With the **Digital tomosynthesis** mammography, 3D views of the breast can be obtained, where multiple images of the breast are acquired from different angles and reconstructed into the three-dimensional image set.

The main advantage is that its ability to detect masses in dense breasts that are likely to get missed on conventional mammogram assessment of breasts masses.

The other technique called **ductography** is done in patients presenting with the nipple discharge, to characterise the mass within the

dilated ducts and evaluate the cause of duct ectasis. Prior to cannulation of ducts, a subareolar craniocaudal magnification view is obtained to assess the presence of any calcifications or opacities in breast parenchyma. A gentle periareolar massage with minimal pressure on "trigger zone" may produce the nipple discharge. This zone is cannulated with a straight tip or right angled tip cannula followed by slow injection of iodinated contrast material. Imaging is then performed to assess the dilated ducts and better evaluation of intraductal masses such as papillomas or carcinomas.

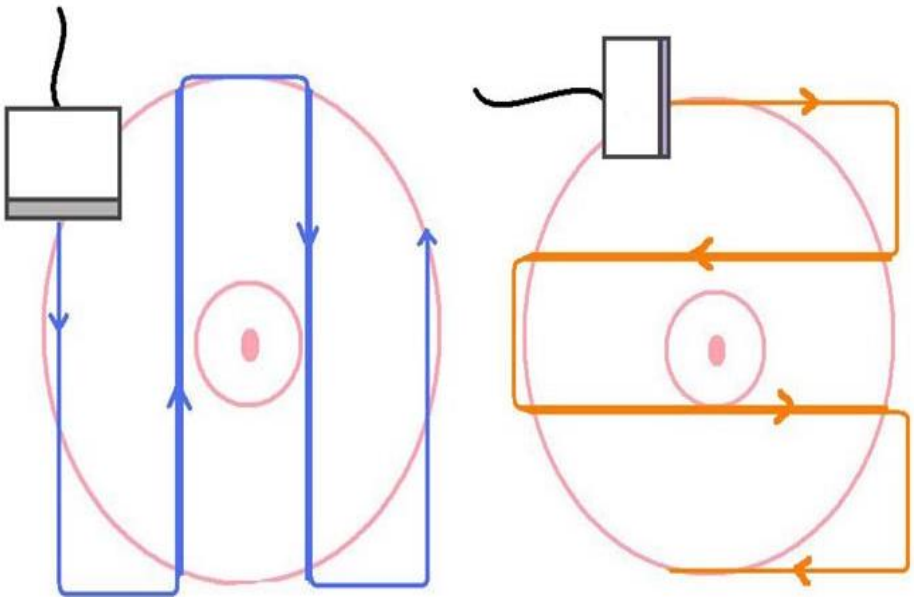
High frequency linear array transducers and high-resolution **Ultrasonography** with the combination of harmonic imaging and with real-time compounding helps in better characterization of the mass lesion even in cases with dense breast. USG can aid in localizing small foci of breast cancers that are readily missed on routine X- Ray mammography screening [19].

The linear 5 to 12 MHz transducer is the optimal one in assessing superficial parts of the body, including breasts, since it provides a better lateral resolution. The **harmonic imaging** augments the resolution of sonographic images and also reduces the hindrance from reverberation or the near-field artifacts. Real-time **compound scanning** adds to a better tissue contrast resolution.

B mode Ultrasonography is chosen as the initial imaging modality woman younger than 30 years presenting with the palpable breast lump. USG aids in better evaluation of mammographic findings such as mass like opacities and any focal asymmetric mammographic densities.

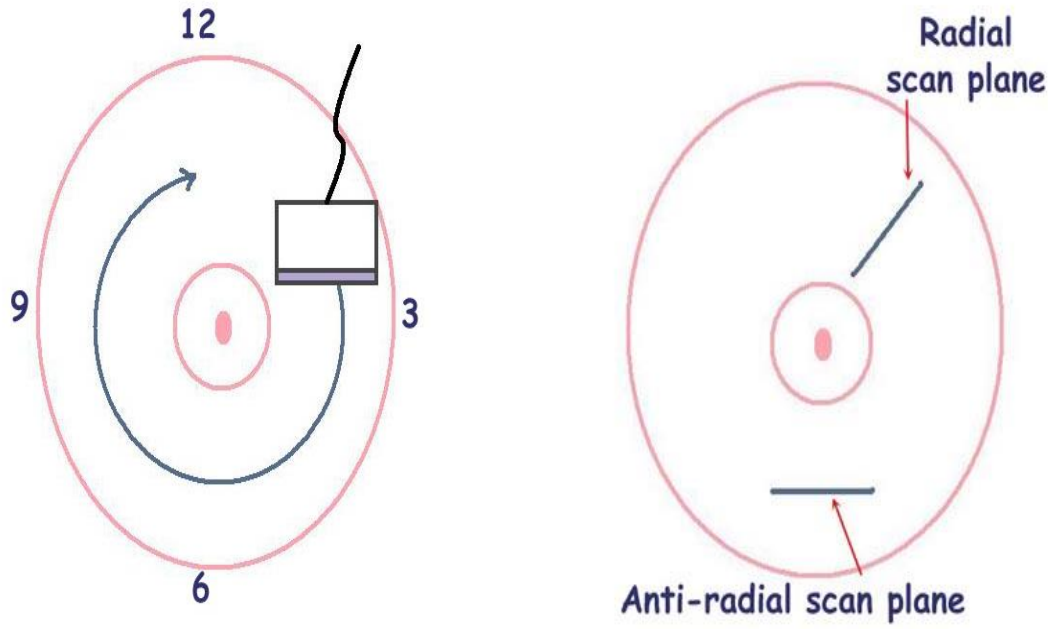
Grid technique is widely adopted for routine breast ultrasound.

Scanning begins transversely in upper outer quadrant, and then sliding from top to bottom inferiorly, the similar sweep is repeated in saggital plane.



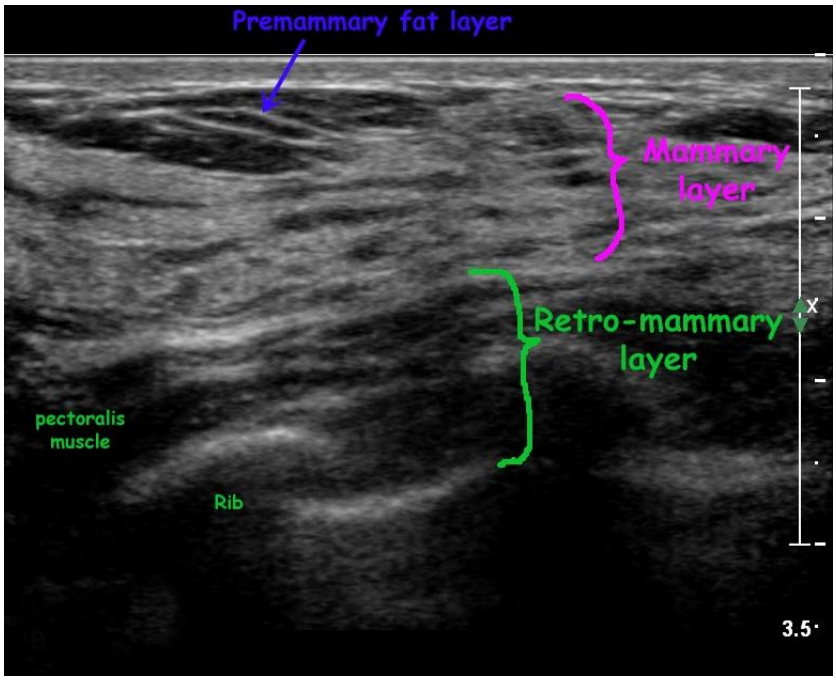
Other adopted technique for breast USG is radial scanning pattern:

Starting at 12'o clock position, in the saggital plane, the probe is turned around the nipple. The same is done in radial and anti-radial plane

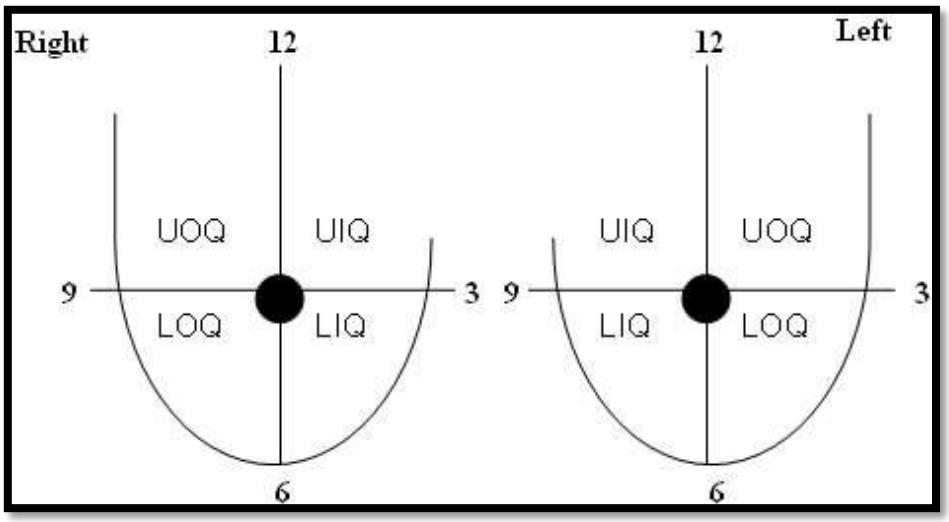


Normal breast anatomy in USG is divided into **three zones** :

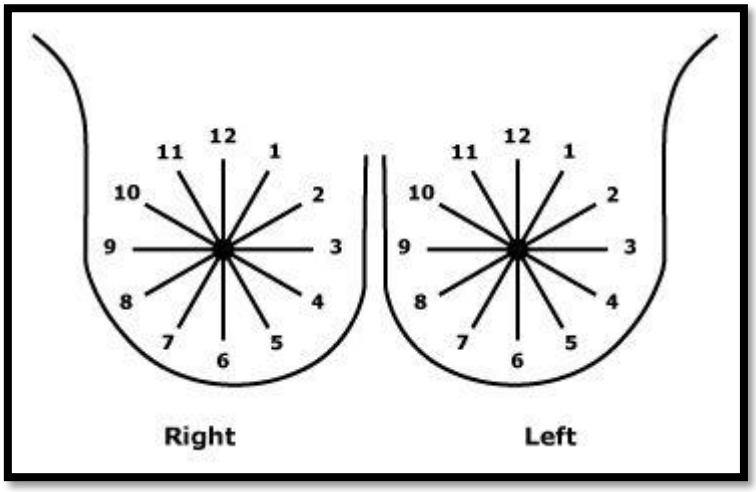
1. Pre mammary zone(skin and fat)
2. Mammary zone(fibroglandular tissue)
3. Retro mammary zone(fat and muscles of chest wall)



Breast lesions are located in terms of **4 quadrants**: upper inner, upper outer, lower inner and lower outer.



Description in terms of clock positions can precisely locate the breast pathologies.



The US lexicon of Sonomammogram includes six morphologic features of the solid breast masses such as

- Shape of the lesion
- Orientation of the lesion
- Margin of the lesion
- Boundary of the lesion
- The echo texture of the lesion and
- Posterior acoustic features of the mass

Orientation and shape of the lesion:

Orientation of a breast mass can either be parallel or non parallel to the skin surface of the breast.

Shapes can be round or oval. Round (spherical, circular or globular) shape is associated with a relatively high probablity of malignancy(60%-100%).

Oval (elliptical or egg like) shaped mass is described as “gently lobulated” (having two to three fine undulations) or “macrolobulated” (if more than three).

Margins of the lesion :

The margins of solid breast masses may either be circumscribed or noncircumscribed.

Well defined mass with a sharp zone of transition from the surrounding breast tissue is described to have circumscribed margins.

Presence of an indistinct zone of demarcation between the mass and the surrounding breast tissue is noncircumscribed margins.

Angular margin is described if a lesion has sharp corners. Spiculated margins are described when there are lines radiating from the periphery of the mass.

Angular margins and spiculated margins are highly associated with malignancy with their incidence rates of 60% and 86% respectively.

Lesion boundary:

Can either be a sharp interface between the mass lesion and the surrounding normal breast or a wide echogenic transition zone which lack sharp demarcation from the rest of tissue. In most cases, a lesion with a

sharp interface will be benign and with echogenic wide transition will be malignant.

Internal echotexture:

The echotexture of a breast lesion is described in reference the subcutaneous fat within the breast. The lesion can be hypoechoic, isoechoic or hyperechoic compared to the subcutaneous fat.

Posterior acoustic features:

Posterior acoustic shadowing is a suspicious finding and may be associated with cases of complex sclerosing lesion, invasive carcinoma, postoperative scar, lymphoma or macrocalcifications and may even be seen in normal patients with dense breast tissue..

In case of doubts in assessment of posterior acoustic enhancement, compound imaging settings aid in sorting them better.

Other associated features to be looked for on Sonomammography are: the presence of

- Architectural breast parenchymal distortion
- Dilated ducts
- Vascularity of the lesion
- Overlying skin and nipple changes.

Criteria for benign breast lesions on USG are [20],[21]:

- Masses with well circumscribed and smooth margins
- Hyperechoic masses, isoechoic or mildly hypoechoic masses
- Thin echoic capsule around the mass
- Oval shaped masses with the maximum diameter in the transverse plane
- Three or less microlobulations.

Breast ultrasound criteria for characterisation of malignant lesions are:

- Mass having ill-defined borders
- Spiculated / angular margins
- Grossly hypoechoic lesion
- Taller than broader-the maximum diameter in the longitudinal plane
- Associated Posterior acoustic shadowing and
- Microcalcifications

Doppler USG:

Malignant breast mass are associated with high vascularity, more number of centrally located vessels. Since malignant neoplasms require neo - angiogenesis for its further growth and metastasis. Doppler criteria

such as Resistive Index (RI), Pulsatility Index, and flow velocity can aid in distinguishing the benign from malignant lesions. Malignant masses mostly have a higher RI than the benign ones.

USG elastography:

The use of USG elastography is being increasingly used in diagnosis of malignant breast masses, in recent times. The studies conducted by **Zhi H et al**[22] and **Itoh et al** [23] on USG elastography highlights that combined use of B-mode USG with Sonoelastography can greatly augment the specificity and positive predictive value in precise characterization of the breast masses. Elastography is a novel noninvasive technique based on evaluation the stiffness or the elasticity of a lesion.

Elasticity is the mechanical property enabling a substance to get deformed, on subjecting it to an external force and also to resume its natural shape or size when the external force is removed.

Nightingale K. et al study suggested that the deformation of a tissue is inversely proportional to the stiffness/elasticity of its substance, and response time taken by the tissue to return to its natural condition varies as a function of the tissue's histotype [24].

Among all tissues, the adipose tissue has greater chance of being deformed. The fibrous tissue takes long time to than adipose or muscle tissue to return to its original state after deformation.

There are two different types of elasographic techniques:

- Strain elastography
- Shear wave elastography.

Strain type of elastography, has two different modalities - strain with manual compression and with acoustic radiation force impulse (ARFI).

In "**strain elastography**", on compression of tissue in the region of interest, the resultant tissue motion takes place in the direction of sonographic beam propagation. The tissues are deformed by applying a slight manual longitudinal compression using the transducer.

The tissue deformation occuring in the longitudinal direction is directly proportional to the intensity of the compression applied on it.

The force applied by the manual compression technique is not known to the USG machine and the degree of the tissue deformation is measured with the variations in radiofrequency of the sonographic beam along the axis of the transducer before and after the compression.

On conversion of the tissue deformation profile into an elastic modulus, the “elastogram” image is obtained [25]. Since it is not possible to define the intensity of the force applied on the tissue, it is only possible to obtain the deformability ratio of the various tissues and the absolute tissue elasticity is not derived. The elastography with compression technique gives only the qualitative information is obtained and not the quantitative data.

ARFI is done in two different ways. One is a **qualitative** method, similar to strain elastography, which utilises a high intensity short acoustic impulse and deform the tissues to create a static elastogram map of the tissue’s relative stiffness.

Another technique is **quantitative** type, similar to shear wave elastography, in which the primary acoustic impulse is focused in the region of interest and it leads to propagation of pressure waves in transverse axis, to cause deformation of the tissues.

The velocity of wave Propagation and attenuation are highly dependant on the stiffness of the tissue under deformation and also on its viscoelasticity. The waves, in general, travel faster in stiffer tissue compared to non stiff tissue.

Both the qualitative and quantitative ARFI methods decreases the interobserver variability but the disadvantage is that it only provides static details on the tissue elasticity and not the dynamic data like compression elastography.

With ARFI, a qualitative gray-scale map obtained depicting the tissue's relative stiffness as defined by the ARFI-box with simultaneous comparision of the corresponding B mode US image. The lighter areas represent more deformable tissues than the dark appearing areas.

Real-time shear velocity (RSV) is a real-time evaluation of the propagation of waves along with the lateral deformability of the tissues. The pressure waves are generated from a conventional transducer and the tissue motion is captured by a sequence images to produce a specially designed beam [26] .

By measuring the local propagation velocity of the pressure waves, the RSV creates a two-dimensional map representing the distribution of pressure and the visco-elastic properties of the tissues. The exact scores of tissue stiffness are expressed in kiloPascals.

Kumm et al [27] study combined both the elastography score and strain ratio to characterise the breast lesions, to reduce the need for breast biopsies.

Jung Min Chang et al [28] compared the shear wave with strain ultrasound elastography in their ability to differentiate the benign and malignant breast masses. The AUC for shear wave elastography (0.928) was similar as that of strain elastography (0.943). He concluded that the diagnostic performance of both shear-wave and strain elastography were similar.

However, the sensitivity and specificity of shear-wave and strain elastography were similar to each other. However, the sensitivity and specificity of shear-wave and strain elastography varies according to histology of the, tumor grade and breast thickness.

The elastograms were evaluated using the **Tsukuba Elasticity Scoring**, it is a 5-point strain scale.

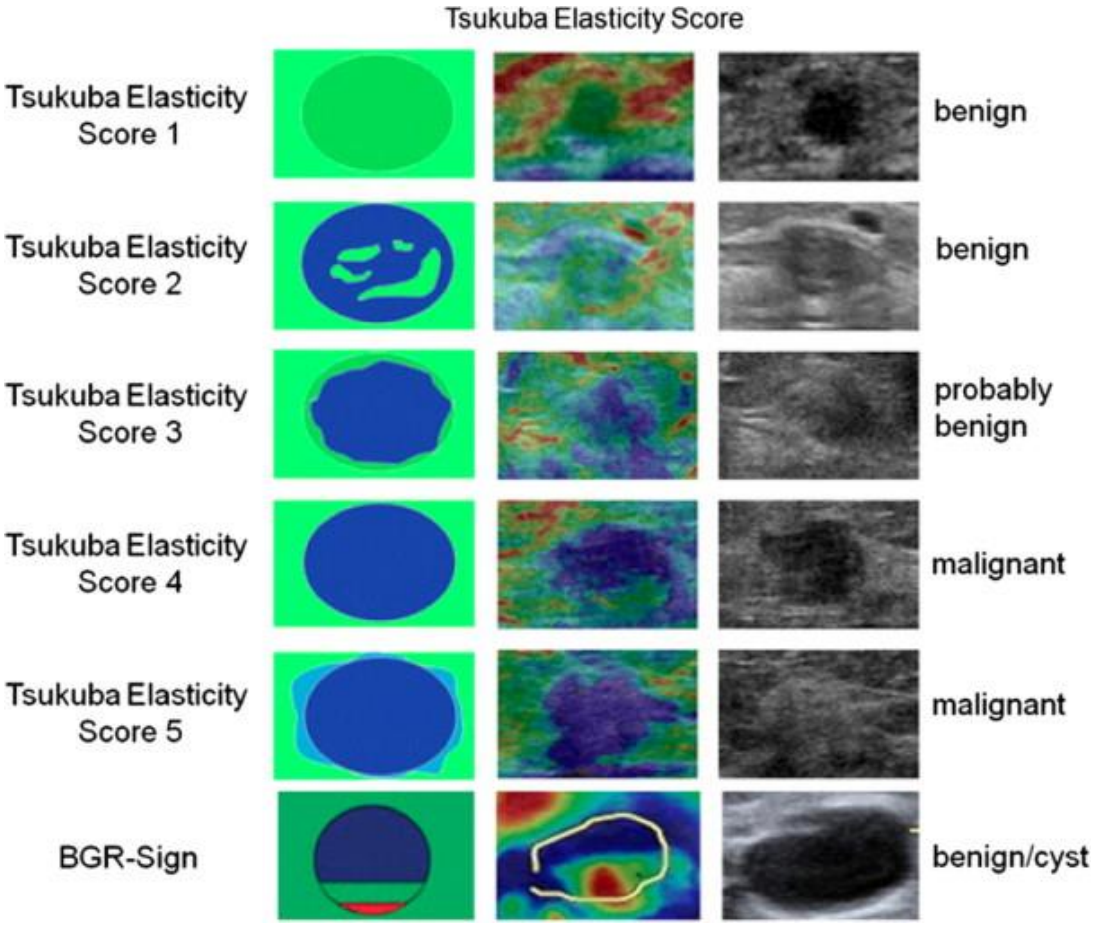
Score 1: strain noted in entire hypoechoic lesion (the whole lesion is seen as green as that of the surrounding normal breast).

Score 2: strain is not noticed in part of the hypoechoic lesion (the lesion is seen as a mosaic pattern of green and blue).

Score 3: strain shown only in the periphery of the lesion and not in the center (the center of the lesion is seen in blue while the peripheral areas are in green).

Score 4: no strain noted in the entire hypoechoic lesion (the entire lesion is seen as blue).

Score 5: no strain seen either in the hypoechoic lesion or in surrounding tissue (both the lesion and surrounding areas are seen as blue).



Dynamic Breast MRI is now the most sensitive tool for early diagnosis of breast cancer. **Kuhl CK et al.** [29] suggested that recent innovations in breast MRI clarify both morphology of the lesion and the contrast enhancement kinetics.

In various studies on utility of MR Mammogram conducted by **Bluemke DA et al**, **Ikeda DM et al** [30,31,32], the sensitivity of MRI breast in the detection of breast cancer is as high as 90% and the specificity varies from 50% to 70%. **Orel SG et al. study** [33] on preoperative evaluation of breast masses by MRI had a sensitivity rate higher than that of both X-Ray mammography and USG. **Hata T et al**. study [34] shows that MRI help in better detection of intraductal spread of breast masses compared to conventional USG or mammography.

A recent study by Bilimoria **KY et al. study** [35] stated that the routine use of MRI in women who were already identified as having breast cancer increases the rate of detection of synchronous disease.

Schnall MD et al [36,37] and few other studies suggested the combined use of assessment of the time-signal intensity curve to an architectural interpretation model results in higher rate of sensitivity and specificity.

The interpretation of MRI breast is by analyzing:

- Morphology of the lesion
- T1 and T2- intensities of the lesion
- Kinetics of contrast enhancement by various curve patterns

Enhancing breast lesions are classified into three major categories: focus/foci, masses, and lesion with non-mass enhancement [38].

- **Focus or Foci** (if multiple) is an enhancing area that is less than 5mm in its diameter.
- A **mass** is a three-dimensional space occupying lesion in the breast.
- **Non-mass like enhancement** is region of enhancement without any detectable three-dimensional mass lesion.

Study by **Malich Aet al** [39] on differentiation of benign and malignant breast masses with MR Mammogram suggests the following factors of interpretation:

Shape of the lesion:

The mass may be round, oval, lobulated with undulating contours or irregular in shape. The irregularly shaped masses have 32% chance of malignancy.

Margin of the lesion:

Margin can be categorised as smooth, spiculated or irregular.

Spiculated margins are frequently associated with malignant breast lesions (80% chance of malignancy).

T1- and T2- features of the lesion:

High signal on T1 images

The common lesions are intramammary lymph nodes with fatty hilum, fat necrosis and hamartomas.

The pre-contrast T1 & non fat suppressed sequence depicts the presence of fat in a lesion.

High signal on T2-fat suppressed images

Lesions appearing hyperintense on T2 images are cystic lesions, lymph nodes and fat necrosis. Most T2 hyperintense lesions are benign.

Only malignant T2 hyperintense lesion is colloid carcinoma.

Moderate signal on T2-fat suppressed images are invasive lobular carcinoma, ductal carcinoma in situ and fibrocystic breast disease.

Low signal on T2-fat suppressed images are invasive ductal carcinoma, scars and sclerotic fibroadenomas.

Focal perilesional Edema:

A focal region of T2-hyperintense signal around the lesionis highly suspicious of malignancy.

The hyperintensity increase may be related to presence of increased capillary permeability by the tumour related angiogenesis growth factors.

Architectural Distortion:

A nonenhanced architectural distortion usually represents radial scar; and enhanced architectural distortion usually represents invasive cancer. Desmoplastic tethering (hook sign), which is highly suggestive of a malignant breast mass is due to invasion of the Cooper ligaments along the pectoral muscle direction.

Skin Thickening and Edema:

Skin thickening and edema associated with breast mass (untreated) are signs of malignancy, mostly of inflammatory carcinoma. In the treated breast cases, these occur frequently following radiation therapy.

Lymph Nodes:

The mere absence of lymphadenopathy does not differentiate benign from malignant masses. Presences of nodes with more than 1 cm diameter are seen in malignant masses.

A lymph node with loss of fatty hilum is seen in malignancy.

Breast mass enhancement patterns on MRI:

- Homogenous enhancement is presence of uniform and more confluent enhancement in the entire mass.
- Heterogeneous enhancement is when there is non uniform enhancement; the enhancement varies with mass lesion.

- Rim enhancement is enhancement concentrated in the periphery of the mass, has 40% chance of being malignant. It is commonly a feature of high-grade invasive Ductal cancer, fat necrosis, and also in few inflammatory cysts.
- Enhancing internal septations are the common feature of malignancy.
- Central enhancement is the enhancement of the nidus within a mass. Usually associated with high-grade Ductal carcinomas.

The Kinetic curve analysis:

The initial upslope of the curve in first one to two minutes, can be slow, medium or rapid upslope.

The delayed portion is more than two minutes after the injection of contrast can be persistent increase , plateau or washout.

Type 1 curve:

Has a slow rise in initial phase with a persistent rise with time.

A lesion having type 1 curve has 6% chance of malignancy

Type 2 curve:

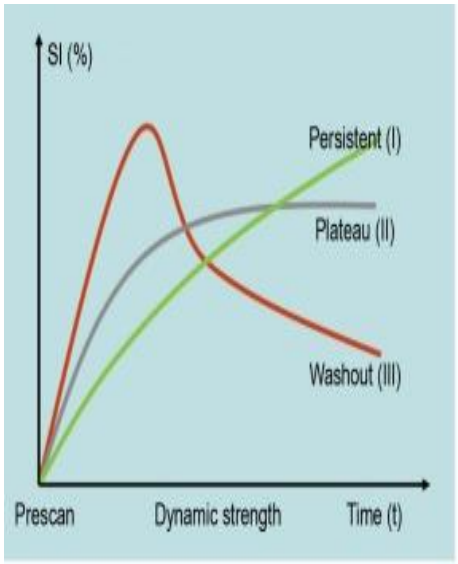
May have either a slow or rapid rise in the initial phase followed by a plateau in delayed phase, which has a variance of 10% up or down.

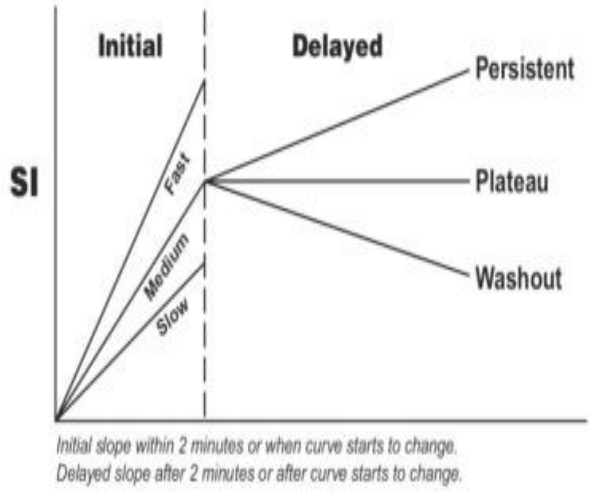
A lesion with type 2 curve has 29-77% chances of malignancy.

Type 3 cure:

The type 3 curve has a rapid rise in initial phase, followed by a rapid washout in the delayed phases.

A lesion with type 3 curve has high (29-77%) chances of malignancy.





Non-mass like enhancement:

- Focal enhancement is when the non-mass enhancement occurs in less than 25% of a quadrant in the breast.
- Ductal involvement shows enhancement along a ductal distribution and has a 60% chance of malignancy.

- Linear enhancement has enhancement similar to ductal type of enhancement, but has no ductal orientation. There is 31% chance of malignancy.
- Segmental enhancement refers to enhancement along multiple ducts and is associated with 78% chance of malignancy
- Regional enhancement is neither ductal nor segmental but larger than focal enhancement and is associated with 21% chance of malignancy
- Diffuse non-mass enhancement occurs typically in benign masses.

Internal Enhancement Pattern in Non-mass like enhancement

The **punctuate** enhancement occurs mostly in benign lesions and is associated with 25% chance of malignancy.

Clumped enhancement is another important non-mass enhancing pattern, and is associated with 60% chance of malignancy.

Heinig et al, study stated the USG characterisation of breast lesions using BIRADS-US criteria [40].

BIRADS:

BIRADS classification is devised by American College of Radiology, last updated in November 2015, and is the widely used classification system for breast masses.

The latest version classifies the breast lesions into six broad categories:

- **BIRADS 0:**
  - Incomplete imaging, further imaging or information is required, such as compression, magnification or other special mammographic views.
  - When the previous image not available at the time of examination.
  - Once the additional imaging studies are completed, a final assessment is done.
- **BIRADS 1:** negative mammogram, symmetrical breast tissue and no detectable masses, no architectural distortions or no suspicious calcifications seen.
- **BIRADS II:** benign finding such as
  - Fat-containing lesions such as: oil cysts, breast lipomas, fibroadenolipoma or mixed density hamartomas and galactoceles
  - Simple breast cysts
  - Follow up after breast conservative surgery
  - Calcified or Involuting fibroadenomas
  - Intramammary lymph nodes
  - Vascular calcification
  - Breast Implants

In BIRADS II lesions, a routine screening mammogram is suggested. No invasive procedure needed as the chance of malignancy is 0%

- **BIRADS III:** probably benign, short interval follow-up (6 months) or continuous surveillance is suggested. Likelihood of malignancy is more than 0% and less than 2%. This includes
  - Nonpalpable, circumscribed mass on a routine mammogram (unless it can be shown to be a simple cystic lesion, an intramammary lymph node, or any another benign finding).
  - Focal asymmetry which becomes less dense on spot compression view
  - Solitary group of punctuate calcifications

The initial short term follow-up of a BIRADS III lesion is an unilateral mammogram at 6 months, then a bilateral follow-up of examination is suggested at 12 months interval. Assuming stability perform a follow-up after one year and optionally after another year.

If the finding shows no change in the follow-up, the final assessment is changed to BIRADS II (benign) and no further follow up is needed.

- **BIRADS IV**: suspicious abnormality requires biopsy.
  - There is a mammographic appearance which is suspicious for malignancy
  - These can be further divided as
- BIRADS IVa: low level of suspicion for malignancy
- BIRADS IVb: intermediate suspicion for malignancy
- BIRADS IVc: moderate suspicion for malignancy
- **BIRADS V:** there is a mammographic appearance which is highly suggestive of malignancy, biopsy should be taken
- **BIRADS VI:** a biopsy/ histopathology proven malignancy

PATHOLOGY AND PROGNOSIS OF MALIGNANT BREAST MASSES:

Breast carcinomas generally arise from the terminal duct lobular unit (TDLU). Breast cancers are broadly divided into two groups: the carcinomas and the sarcomas.

Carcinomas contribute to the vast majority of all breast cancers; they arise from the epithelial cells in the breast.

Sarcomas are rare masses that arise from the stromal (connective tissue) cells of the breast.

In situ (preinvasive) carcinoma is when the lesion not yet invaded the surrounding breast tissue. Masses that originates from the ducts are known as **ductal carcinomas**, while those from the lobules are known as **lobular carcinomas**.

Ductal carcinoma in situ (DCIS) is subdivided to comedo, solid, cribriform, papillary and micropapillary histological types. It takes many years for the transformation of pure DCIS to an invasive ductal mass [41].

Lobular carcinoma in situ (LCIS), show lack of E-cadherin and Beta catenin expression in the tumour cells and also associated with presence of high molecular weight (HMW) keratin [42]. Invasive carcinoma develops in about 25%-35% cases (at a rate of 1% per year) who are observed for more than a period of 20 years.

Approximately 80% of breast carcinomas are mainly **invasive ductal carcinoma**, followed by 10-15% of cases with **invasive lobular carcinomas**.

Invasive lobular carcinoma (ILC) usually occurs in postmenopausal women and may be related to hormone replacement therapy [41].

Inflammatory Breast Cancer (IBC)- is a rare type of breast carcinoma that is associated with reddening and inflammation of the skin of the affected breast. Most IBC are invasive ductal carcinomas.

Paget ’s disease Of Nipple- an uncommon pathology of breast carcinoma that is associated with red and scaly rash on the skin surface of the breast.

Phyllodes tumour of the breast or cystosarcoma phyllodes, is an uncommon type in which the tumour cells that grow quickly in a leaf-like pattern.

The prognostic factors suggested by College of American Pathologist:

- The axillary lymph node status is the most consistent prognostic factor among all.
- The five year survival for patients with node-negative breast cancer is 82.8% and it is 73% for 1-3 positive nodes, 45.7% for 4-12 positive nodes and it is 28.4% for >13 positive nodes[43]
- Invasive ductal ductal carcinoma and inflammatory breast cancer have high propensity for axillary nodal metastases.
- Size of the tumour - Patients with tumour <1 cm had a 5-year survival rate of 99% as compared with 89% survival for tumours

between 1cm and 3cm and 86% survival for tumours between 3cm and 5cm[44].

- The presence of lymphatic/vascular invasion
- Age of the patient influences the prognosis – worse prognosis is in patients younger than 35 years of age.
- Histologic grading by Scarff-Bloom-Richardson (SBR) classification is widely followed - it includes miotic index, pleomorphism and differentiation of the cells and is scored from 1 to 3.
- Histologic subtypes – commonly tubular, mucinous and medullary subtypes have a better prognosis than unspecified breast cancer [45].
- Response to neoadjuvant therapy.
- ER/PR (Estrogen and Progesterone receptors) status

MANAGEMENT OF CARCINOMA BREAST:

Histopathology is the gold standard confirmatory tool in breast masses.

Fine Needle aspiration biopsy (FNAC):

The sample of cells or fluid aspirated from an easily accessible lump is smeared on a glass slide and sent to pathology. Image guidance

such as ultrasound, MRI or mammography is often sought in deep masses not detected on palpation.

This procedure is less invasive, least expensive and it is less time consuming. The limitation is pathologist often cannot tell if the sample from the tumour is carcinoma in situ or invasive breast cancer.

Core-Needle Biopsy:

A wide bored hollow needle is used to take out several small core of tissue (about 1/16 to 1/8 inch in diameter and about ½-inch long) via biopsy gun.

Vacuum-assisted breast biopsy (VABB):

With vacuum assistance, required sample can be obtained via a single insertion. The advantage of complete lesion removal with VABB are to eliminate the sampling error, to reduce the likelihood of a histological underestimation, to decrease the rate of re-biopsy.

Open (surgical) biopsy:

There are two types:

The excisional surgical biopsy – complete removal of the lesion concern along with the surrounding margin of normal breast tissue.

In incisional surgical biopsy – only a part of the breast lesion is removed. This biopsy is usually done on large lesions.

With “needle” or “wire” localization, a thin wire is inserted via the center of the hollow needle to precisely localize the exact area of biopsy. The hook at the wire end prevents it from slipping out of the soft breast tissue.

The radiologist then will remove the hollow needle, and only the wire will be left as a guide to localize the breast mass.

Surgery:

Based on the type and the stage of the breast tumour with the aim of complete excision of the mass with clear margins, Surgery can be lumpectomy (removal of the mass alone), quadrantectomy (one- fourth of breast is excised) or mastectomy (removal of entire breast tissue). Sentinel lymph node resection is been increasingly practised along with breast surgeries.

Radiotherapy:

External beam radiotherapy or brachytherapy is administered to the post operative bed in cases of conservative breast surgeries.

Chemotherapy:

Conventional or liposomal Doxorubicin or Daunorubicin is widely used.

Other drugs include Cyclophosphamide, Flurourcail, Mitoxantone and Paclitaxel.

Hormone therapy:

Hormone therapy is used as a neoadjuvant or adjuvant treatment modality, mainly in cases of hormone receptor positive cases such as ER (Estrogen Receptor) PR (Progesterone Receptor) positive.

Tamoxifen is the widely used drug with anti-estrogenic activity. Toremifene is less commonly used drug with similar activity. Aromatase inhibitors such as Letrozole, Anastrazole and Exemastane are other alternatives.

Gene therapy:

Includes oncogene inactivation that interferes with the activation of erbB-2 and activation of tumour suppressor gene such as p53.

STAGING OF BREAST CANCER

Stage 0	Tis , N0 , M0	* Ductal or Lobular carcinoma in situ (DCIS) ,
Stage IA	T1 , N0 , M0	The tumor is 2cm and has not spread to lymphnodes (N0) or distant sites(M0)
Stage IB	T0 or T1 , N1 , M0	Tumor is 2cm with micrometastases in 1 to 3 axillary lymph nodes
Stage IIA	T0 or T1 , N1 (but not N1) , M1	Tumor is 2cm and either : It has spread to 1 to 3 axillary (underarm) lymph nodes with the cancer in lymphnodes greater than 2mm across (N1a). OR Tiny amounts of cancer are found in internal mammary lymph nodes (those near the breast bone) on sentinel node biopsy (N1b). OR Cancer has spread to 1 to 3 axillary lymph nodes and to internal mammary lymph nodes (those near the breast bone) on sentinel node biopsy (N1c).
	OR	
	T2,N0,MO	Tumor is more than 2cm to 5cm
Stage IIB	T2,N1,MO	Tumor is more than 2cm to 5 cm but not more than 5cm across. It has spread to 1 to 3 axillary lymph nodes and/or tiny amounts of cancer are found in internal mammary lymph nodes on sentinel node biopsy (N1).

	OR	
	T3,N0,MO	Tumor is larger than 5cm across in size but does not grow into the chest wall or skin (T3).
Stage IIIA	T0 to T2,N2,MO	The tumor is not more than 5cm. It has spread to 4 to 9 axillary lymphnodes, or it has enlarged the internal mammary lymph nodes (N2).
	OR	
	T3,N1 or N2,MO	Tumor is larger than 5cm it has spread to 1 to 9 axillary lymphnodes, or to internal mammary lymph nodes (N1 or N2).
Stage IIIB	T4 , N0 to N2 , M0	Tumor of any size growing into the chest wall or skin (T4): # It has not spread to lymph nodes. # It has spread to 1 to 3 axillary lymph nodes and/or tiny amounts of cancer are found in internal mammary lymph nodes on sentinel node biopsy (N1). # It has spread to 4 to 9 axillary lymphnodes, or it has enlarged the internal mammary lymph nodes (N2). The cancer hasn't spread to distant sites (M0). Inflammatory breast cancer is classified as T4 and is atleast IIIB.If it has spread to many nearby lymphnodes (N3) it could be stage IIIC and if it has spread to distant lymphnodes or organs (M1) be stage IV.

Stage IIIC	any T , N3 , M0	The tumor ia any size (or cant be found) , and one of the following applies: # Cancer has spread to 10 or more axillary lymph nodes (N3). # Cancer has spread to infraclavicular lyph nodes (N3). # Cancer has spread to supraclavicular lyph nodes (N3). # Cancer has spread to 4 or more axillary lymph nodes and/or tiny amounts of cancer are found in internal mammary lymph nodes on sentinel node biopsy (N3). The cancer hasn't spread to distant sites (M0).
Stage IV	any T , any N , M1	The cancer can be any size (any T)and may or may not have spread to near by lymph nodes (any N). It has spread to distant organs or to lymph nodes far from the breast (M1). He most common sites of spread are the bones , liver , brain or lungs.

AIMS AND OBJECTIVES

- To assess and compare the accuracy of Sonoelastogram breast and Dynamic MR Mammogram in predicting benign vs. malignant breast masses in BIRADS III & above lesions.
- To assess the ability of ultrasound elastography and MR Mammogram to predict malignant nature of breast masses, with subsequent recommendation for biopsy.

MATERIALS AND METHODS

STUDY METHODOLOGY:

STUDY DESIGN:

Prospective cohort study

STUDY PERIOD:

From August 2016 – May 2017, for a period of 10 months

STUDY POPULATION:

Female and male patients, who present with breast masses, of age group 25 years and above.

Study population is chosen from the patients who attend Out Patient Department in Government Kilpauk Medical College and Hospital, Chennai.

INCLUSION CRITERIA:

- Case presenting with breast masses of age 20 years and above
- Cases with BIRADS III and above categories (on assessment with digital ammogram and conventional B mode Ultrasonogram)
- Breast masses more than 5 mm in size (elastogram can be fruitful only in lesions more than 5 mm)

- Cases who have undergone imaging with both sonoelastogram and MR Mammogram
- Cases with histopathological proof

EXCLUSION CRITERIA:

- Lesions that were BIRADS I & II on initial assessment
- Lesions in postoperative breast (the fibrous changes in post operative breast provides a false positive high score on elastogram)
- Cases who are non complaint for MRI (claustrophobia, patients with metallic implants such as cochlear implants, pacemakers, defibrillators or with metallic catheters)
- Cases with allergy to Gadolinium contrast
- Cases with elevated renal parameters, that prevent the use of Gadolinium contrast medium

DATA COLLECTION:

Data collection was performed in the included study group using a standard questionnaire/ proforma.

Proforma includes the basic patient details such as name, age, sex, address, education status, occupation, dietary habits and history of smoking/ alcohol.

General examination of the patient, local examination of the breast mass by inspection and palpation was also assessed and recorded in the proforma.

METHODOLOGY:

The study was begun after obtaining institutional ethical committee clearance. All the included cases were subjected to imaging after obtaining written consent.

After basic clinical examination and local palpation of the breast mass, Real-time conventional B-mode Ultrasonography examination were performed in a GE Health care Logiq S7 scanner, with a wide band linear array probe of 7.5 MHz frequency (5 – 13 MHz), with a foot print of 12.7 x 47.1 mm.

Sonographic assessment of location of the lesion in terms of:

- Quadrant of the breast (upper outer, upper inner, lower outer and lower inner)
- Zone in which the lesion was located
- Clock's position

Other sonographic features described were:

- Echotexture of the lesions were defined as hypoechoic or isoechoic or hyperechoic (compared with the subcutaneous fat)

- Margins of the lesion – well defined, ill defined, spiculated, lobulated
- Presence of axillary nodes
- Categorised BIRADS of the lesion with sonogram

Total of 166 cases with breast masses were sent from Out Patient Department. Among them, conventional B mode Ultrasonogram was performed in all cases. They were categorized according to BIRADS classification.

BIRADS I and II were excluded. 63 cases with BIRADS III and above were chosen for the study. Sonoelastogram was performed in all 63 cases. MRI Mammogram with dynamic contrast was performed only in 51 cases. HPE (Histo Pathological Examination) was done only in 45 cases.

The included sample size in this study is 45 cases **(44 female and 1 male).**

All 45 cases were subjected to sonoelastogram and MR Mammogram within a maximum period of 7 days interval and HPE proof was obtained in all cases within 15 days from their initial imaging diagnosis.

Histopathology was confirmed with open breast biopsy in 26 cases, core needle biopsy was done in 11 cases and FNAC in 8 cases. Among all open breast biopsies, Needle localization assisted surgical biopsy performed in 2 cases.

With the patient in supine position, after obtaining clinical history and initial local examination, Conventional B mode USG breast was done by grid technique either in radial plane.

Only lesions with BIRADS III & above are chosen for the study.

After localization of the lesion, sonoelastogram was performed immediately in the same sitting. Strain wave elastogram was performed with the same linear array transducer. The elastography parameters were set uniform for all cases as color gain at 26%, high frame rate and density at 2.

The probe was placed perpendicular to the breast and parallel to long axis of the mass lesion. Care was taken to avoid lateral angulation of the probe.

The elastography box was chosen large enough to the cover the lesion. Usually the cephalic end of the box is placed under the skin, including the subcutaneous tissue and the caudal end of the box is placed

to include the underlying pectoralis major muscle; lateral borders were usually set more than 5 mm from the lesion's boundary.

The lesion should be within the center of the box. Then, few consecutive compressions- decompressions were manually applied with the probe on the breast and the adequacy of the compression is assessed by the vibration scale in the left corner of the image. A minimum of 3 to 5 acquisitions are obtained per lesion.

During this compression, the grey scale images of the mass lesion were simultaneously seen in the screen and can be used to precisely localize the mass.

Tsukuba elasticity scoring was applied to all lesions depending on the basis of visual color coding. Scores from 1 to 5 were assigned based on its interpretation.

In all cases with suspicious masses, MRI Mammogram was performed in 1.5T GE MRI with the use of dedicated breast coil. Before MR imaging, intravenous access was obtained preferably in antecubital vein for contrast administration.

MRI breast is usually scheduled from 7^{th} to 12^{th} day of the menstrual cycle. This is the optimal phase to avoid misinterpretation from normally enhancing breast parenchyma due to hormonal effects.

Patients were well explained about the procedure and are advised to remove metallic pins, jewellery, hearing aids and other metal objects outside the MRI gantry.

Dedicated breast coils were used. Patients were positioned comfortably in prone position, placing both the breasts into the cups of the breast coil and a cushion is kept under the head. Adequate compression was applied to the breasts with centering at the level of nipple.

The preferable phase encoding directions is from right to left for axial sections and from superior to inferior for saggital sections inorder to avoid the motion artifacts.

The following sequences are usual protocol adopted in our institution for MR Mammogram . Axial and sagittal T1, axial and sagittal T2, axial STIR, DWI, fat saturation images and post contrast T1 dynamic imaging successively for 6 times are obtained.

After obtaining the plain study, intravenous contrast of gadolinium at a dose of 0.1 mmol/kg at a rate of 2ml/sec was administered. It was followed by saline infusion of about 20ml. Subtraction images were obtained by post processing of the contrast enhanced images(pre contrast raw data set is subtracted from each set of post contrast images). These

subtraction images are crucial for exact analysis of contrast enhancement of the lesion. Time intensity curves were obtained with a specific " functool " application.

Parameters set for **T1** were:

TR (repetition time): 400 – 620 ms

TE (echo time): 10 – 30 ms

Flip angle: 90 degrees

Parameters set for **T2** were:

TR: 2000 – 4000 ms

TE: 80 – 120 ms

Flip angle: 90 degrees

Slice thickness: less than 3 mm

Interval gap: 0.5

FOV: 320 x 320 mm

Matrix: 256 x 192

Pixel: less than 1 mm in each plane for dynamic post contrast images to reduce the effect of volume averaging

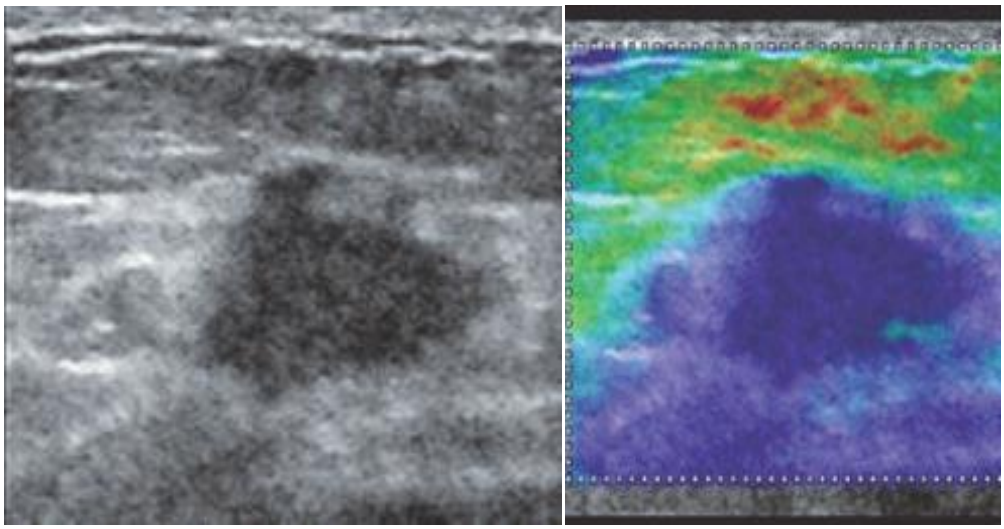
To generate the time intensity curves, ROI was placed on the most enhancing part of the lesion. The size of ROI should preferably be more than 3 pixels.

The curves were described as type I to III. Type I curve is when there is progressive increase in signal intensity on successive images. Type II curve pattern is when there is initial increase in signal intensity, followed by a plateau (flattening). Type III curve is interpreted if there is initial increase in signal intensity, followed by rapid decrease in signal (washout).

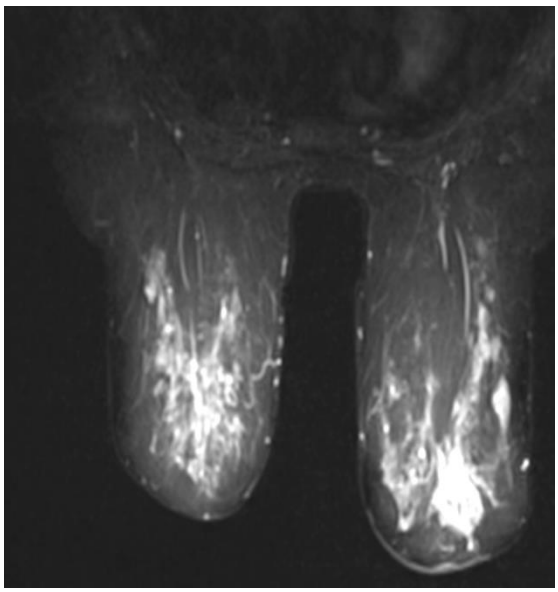
CASE - 1

32 years old female presented with hard lump in right breast.

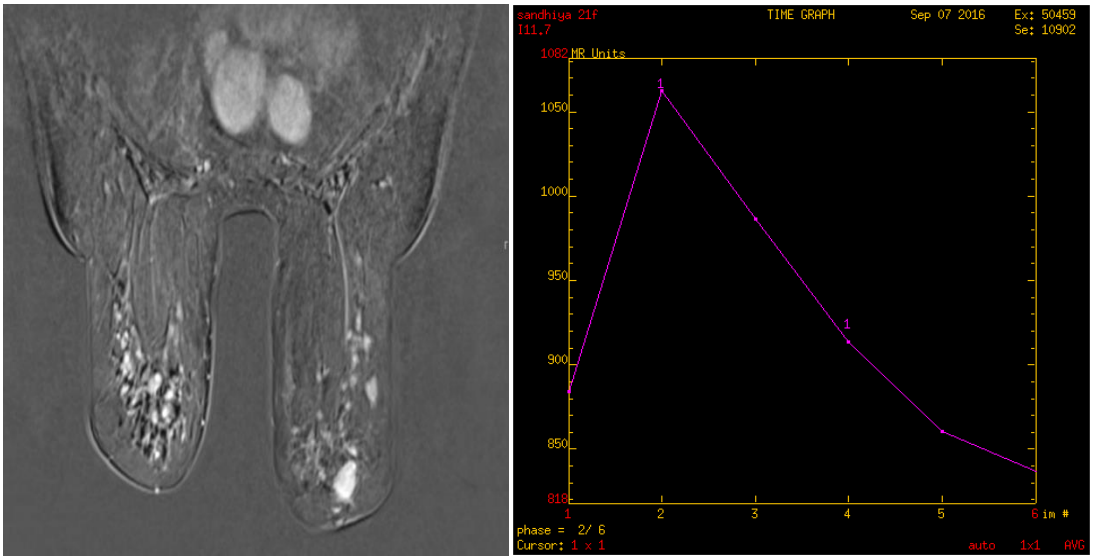
B mode Ultrasound shows a well defined hypoechoic lesion of 2.2 x 1.5 cm with irregular margins. It was categorized as BIRADS IV.



USG Elastogram shows type 5 score as strain seen in entire lesion and also in its periphery.

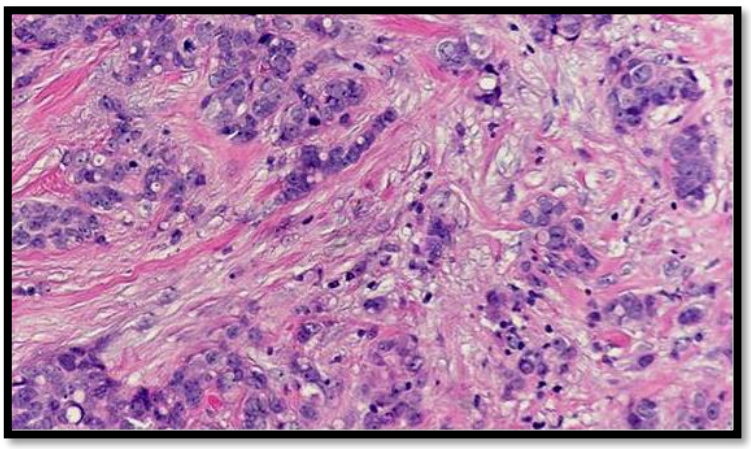


MR Mammogram shows ill defined T1 hypointense lesion and STIR hyperintense lesion in upper outer quadrant of right breast.



Mass lesions in right breast shows intense enhancement in early phase with rapid washout of contrast – suggestive of type 3 curve.

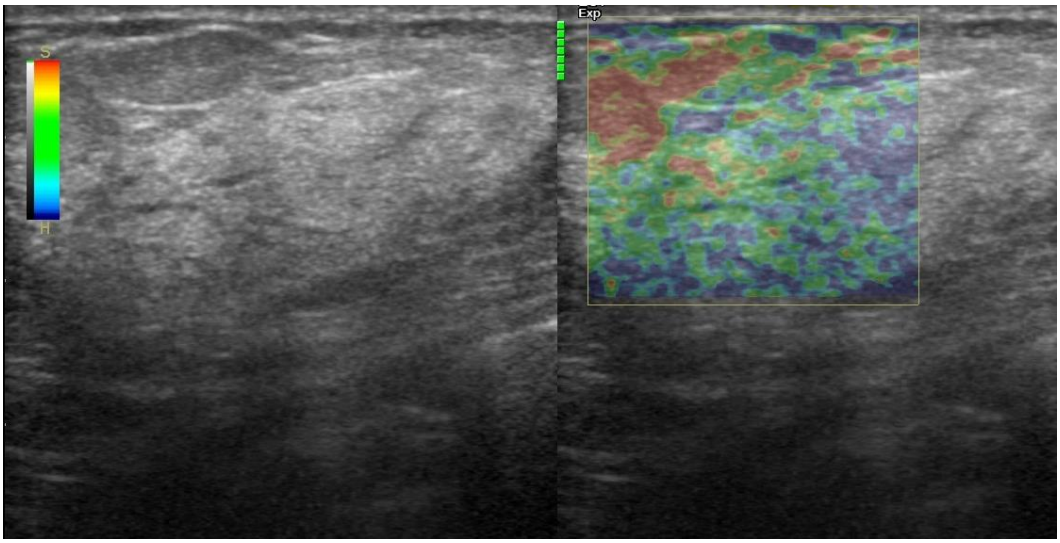
On histopathology, this lesion turned out to be a case of invasive ductal carcinoma.



CASE 2

32 years old young female presented with left breast pain on and off for 2 months and diffuse swelling was noted in left breast on clinical examination.

B mode USG shows ill defined heteroechoic lesion, predominantly hyperechoic in upper outer quadrant of left breast, suggestive of BIRADS III.



On Elastography, the lesion is seen as a mosaic pattern of green and blue, suggestive of score 2.

MR Mammogram shows ill defined T1 hypointense lesion and T2 hyperintense lesion in upper outer quadrant of left breast

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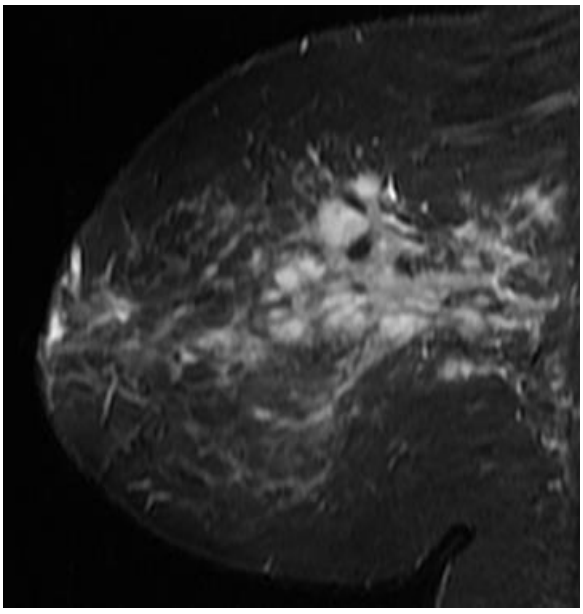
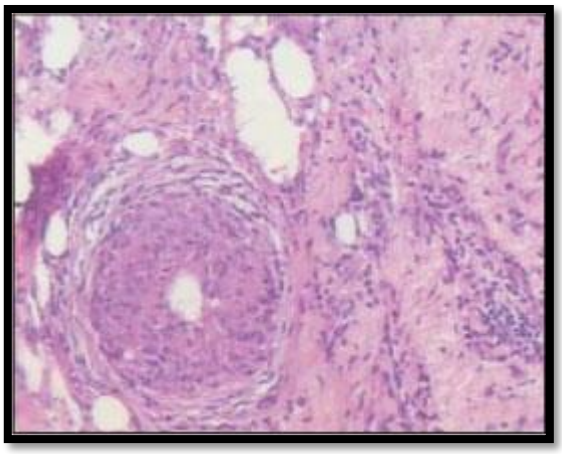


On contrast, non mass like enhancement noted with type 1 curve pattern on kinetic curve analysis.

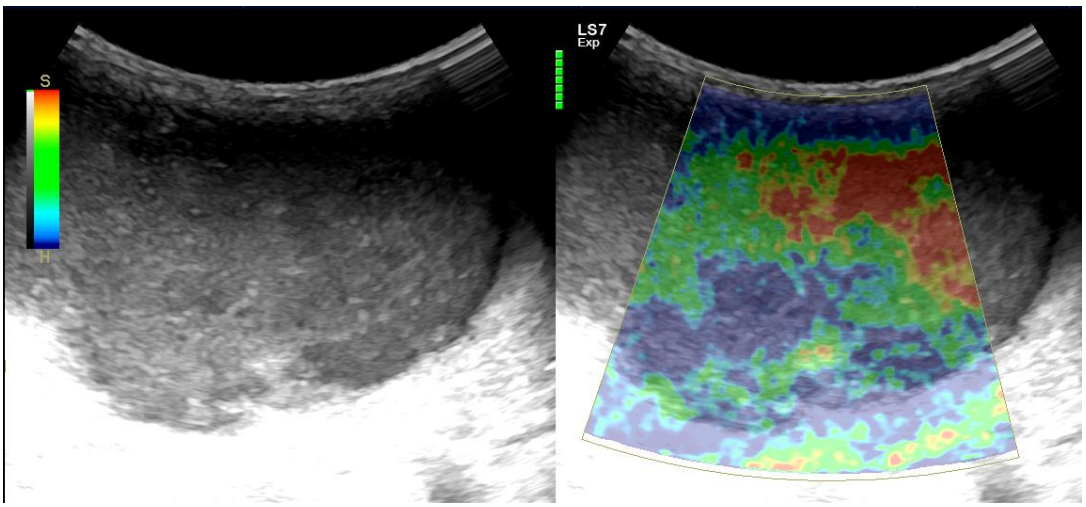
Histopathology – exuberant proliferation of lymphocytes and histiocytes with granulomatous response and focal areas of necrosis in a background of neutophilic infiltrate suggestive of Granulomatous mastitis.



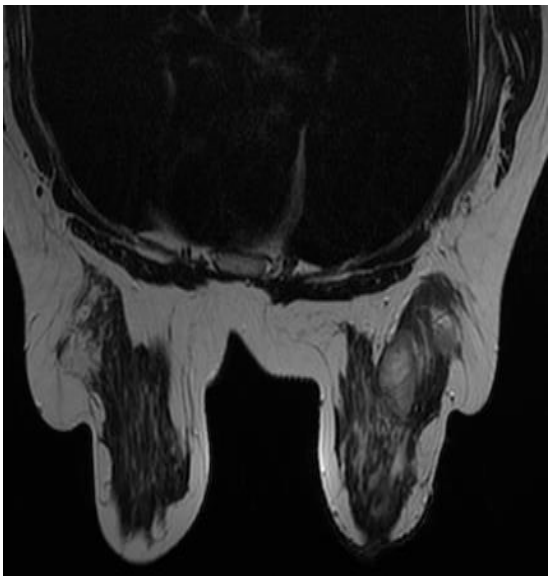
Chronic granulomatous mastitis is mimicker of malignancy, has to be ruled out carefully.

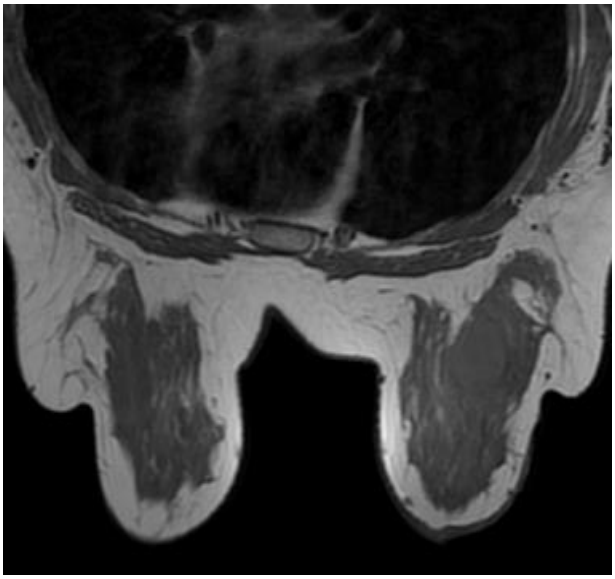
CASE 3

44 years female with large lump in right breast. On USG , large well defined hypoechoic mass lesion with smooth margins measuring 7.0 x 7.2 cm.

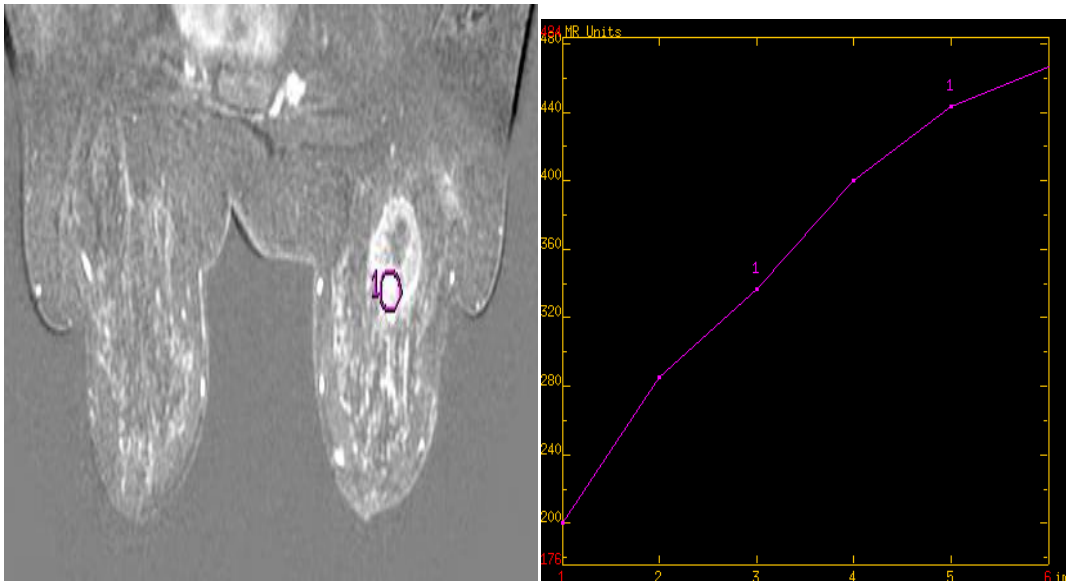


On USG Elastogram, score3 pattern (majority of lesion in blue with areas of green and red mixed within) noted.





MRI T2 & T1 axial images shows a large well defined T2 mixed intense and T1 hypointense mass lesion in right breast with minimally lobulated margins. No evidence of axillary adenopathy.



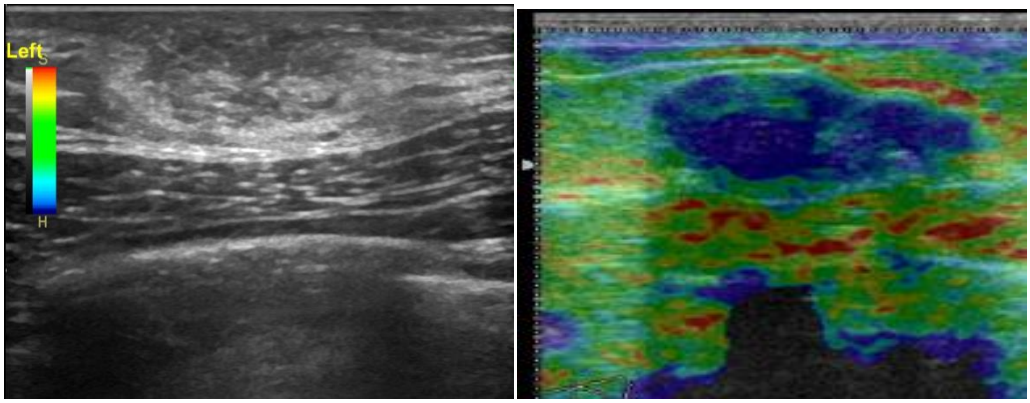
Dynamic contrast MRI shows upslope in initial phase with progressive contrast enhancement in delayed phase – suggestive of a type I curve.

Final histology turned out to be fibroadenoma (giant in size).

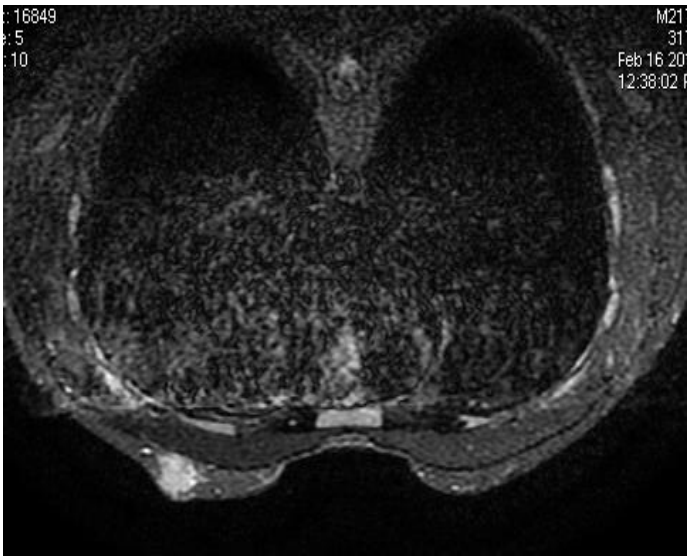
CASE 4

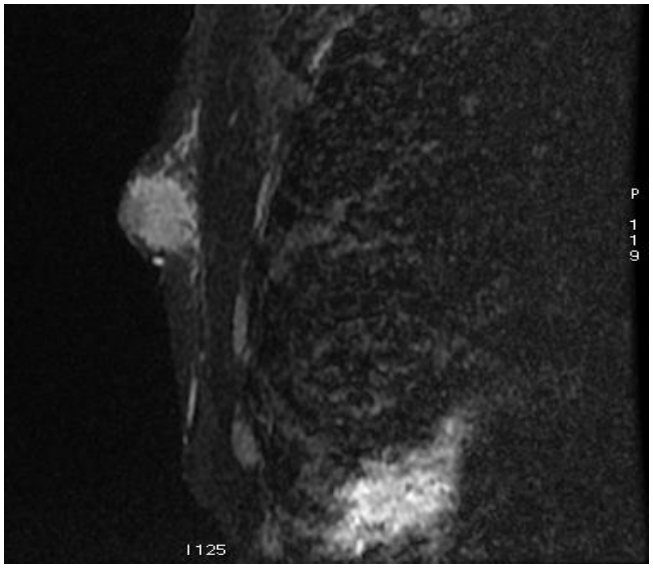
21 years old male presented with painless lump beneath the left nipple.

B mode USG shows heteroechoic mass lesion in the retro areolar region, measuring 2.6 x 2.0 cm with irregular margins suggestive of BIRADS IV.

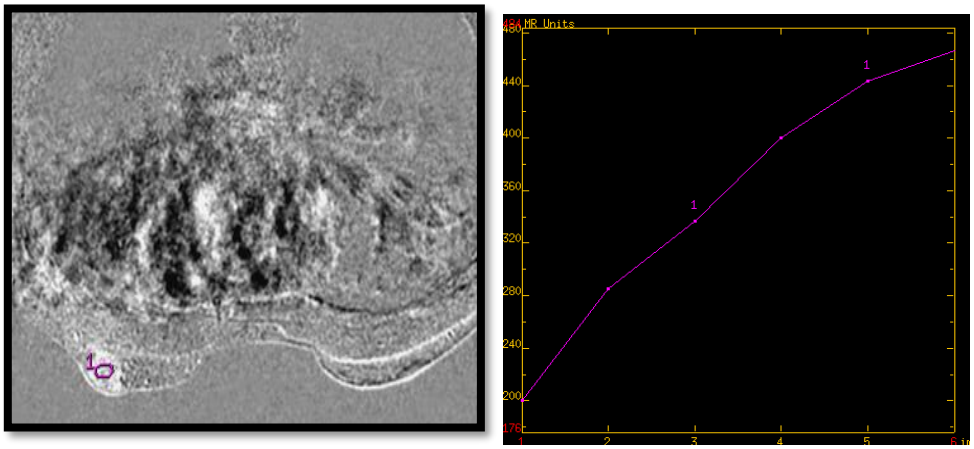


USG elastogram shows predominantly blue colour within the entire hypoechoic lesion suggestive of score 4.

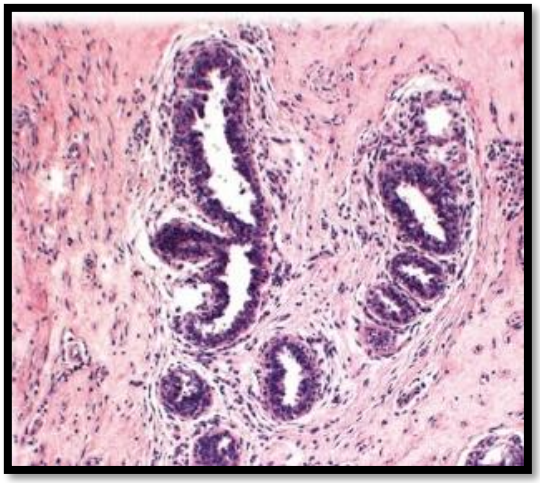




MRI axial and sagittal STIR images show well defined hyperintense mass lesion with irregular margins in left retroareolar region measuring 2.0 x 2.2 cm. Normal right breast and no abnormal axillary nodes.



Dynamic contrast MRI shows progressive contrast enhancement in initial phase and in delayed phase with a type I curve.

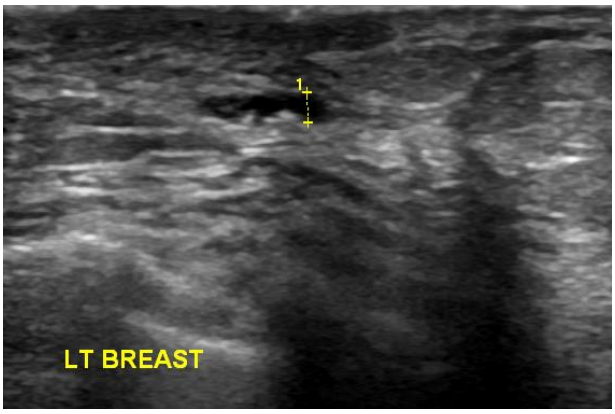


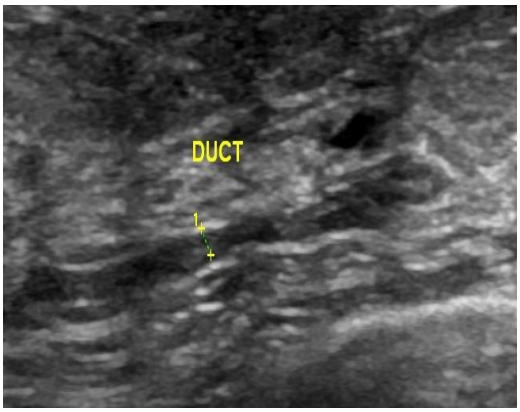
On histopathology, the lesion turned out to be a case of nodular gynecomastia.

CASE 5

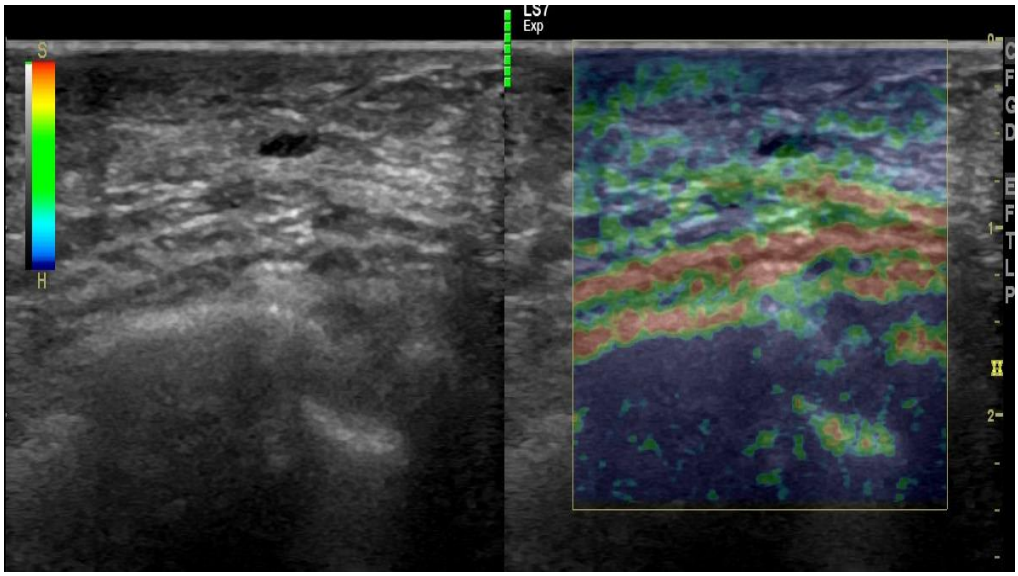
58 years old female presented with bloody discharge from the left nipple.

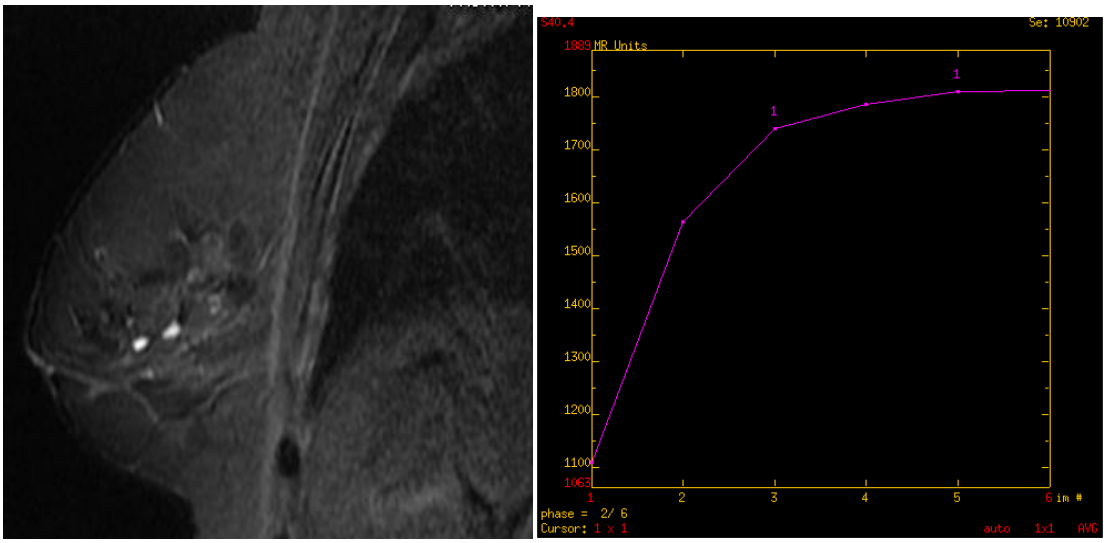
B mode USG shows, dilated duct with few calcifications in retro mammary region.





USG Elastogram shows type 3 score as strain seen only in the periphery of the lesion





MR mammogram shows focally dilated duct along the nipple line.

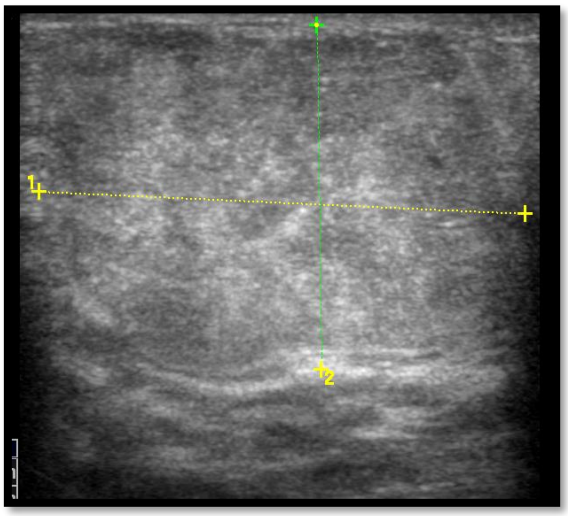
Dynamic contrast MRI shows progressive contrast enhancement in initial phase with plateau in delayed phase with a type II curve.

HPE shows unicentric clonal proliferation of ductal cells with mitotic nuclei without invading the surrounding stroma suggestive of DCIS – Ductal Carcinoma In Situ.

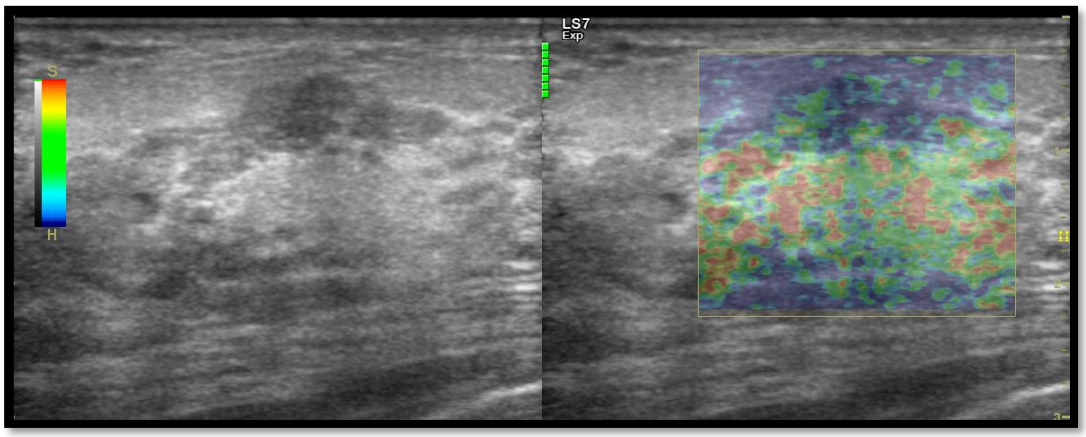
CASE 6

22 years female presented with bilateral breast lumps.

B mode USG shows multiple well defined hypoechoic lesions of varying sizes with lobulated margins in both breasts.



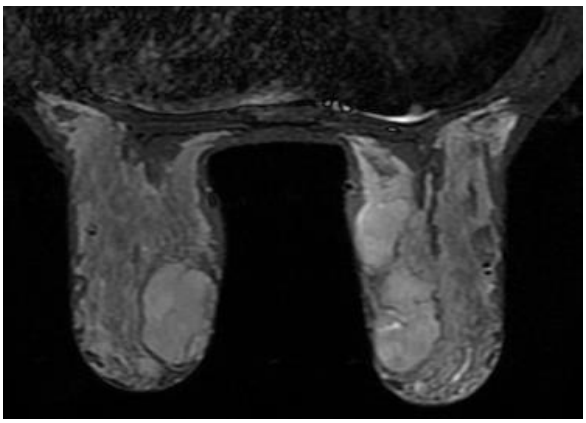
This is the largest lesion in right breast with lobulated margins – suggestive of BIRADS III.



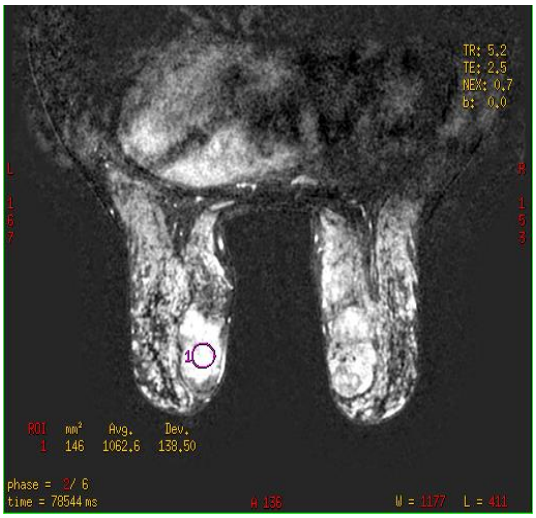
USG Elastogram shows lesion with score 2 strain (mosaic attenuation) pattern in this hypoechoic lesion.

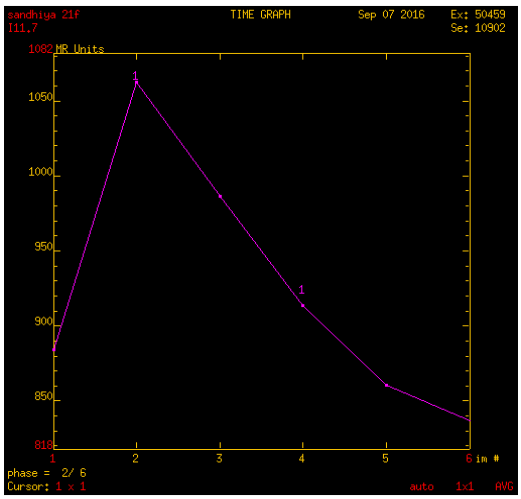
Few other lesions in both breasts had Elastographic score 2 and 3.

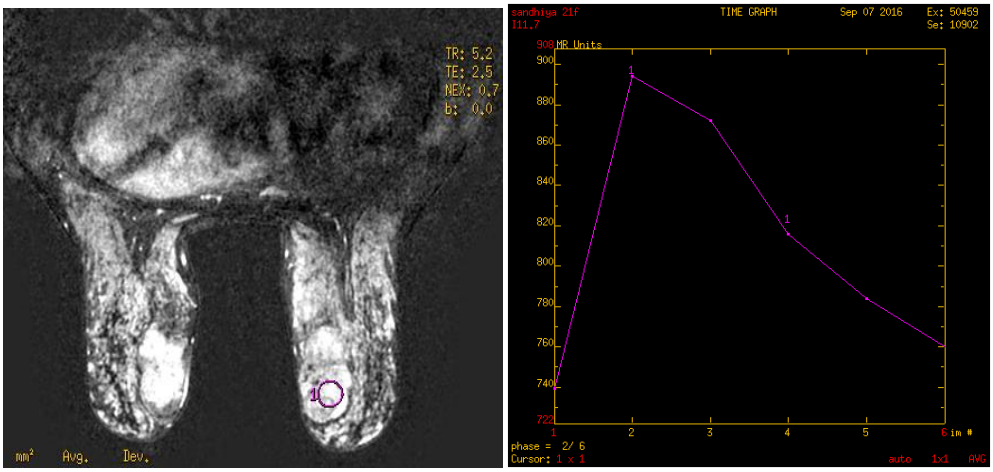
MR T2WI shows well defined hyperintense mass lesions in both breasts with lobular margins in many and irregular margins in few lesions.

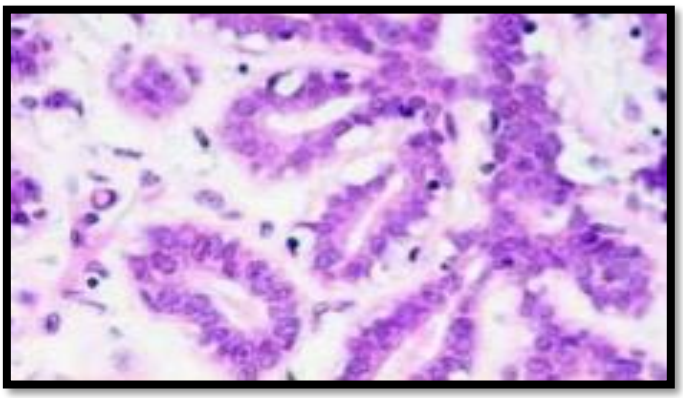


Mass lesions in both breasts shows intense enhancement in early phase with rapid washout of contrast – suggestive of type 3 curve.









On histopathological analysis, both breasts show multiple fibroadenomas in inflammatory background.

STATISTICAL ANALYSIS AND RESULTS

The Data was entered in a excel worksheet and double checked.IBM SPSS version 22 software is used for statistical analysis.

Descriptive analysis:

Descriptive analysis was carried out using mean and standard deviation for quantitative variables.

The frequency and proportion are used for categorical variables.

Data was also represented using appropriate diagrams like bar diagram, pie diagram and box plots.

The sensitivity, specificity, positive and negative predictive values and diagnostic accuracy of the Sonoelastography and Dynamic MR mammogram against gold standard – the Histo Pathological Examination (HPE) along with their 95% CI (Confidence Interval) are computed and presented.

Reliability of the screening test is assessed by kappa statistics along with its 95% CI and P Value.

P value < 0.05 is considered statistically significant.

Table 1: Descriptive analysis for Age in study population (N= 45)

Parameter	Mean ±STD	Median	Min	Max	95% C.I. for EXP(B)	
					Lower	Upper
Age	39.71 ± 11.88	37.00	21.00	74.00	36.14	43.28

Table 2: Descriptive analysis of Age Group in study population (N=45)

Age Group	Frequency	Percentages
Up to 29	9	20.00%
30-39	14	31.11%
40-49	12	26.67%
50-59	8	17.78%
60 and above	2	4.44%

Table 3: Descriptive analysis of Gender in study population (N=45)

Gender	Frequency	Percentage
Female	44	97.78%
Male	1	2.22%

Fig 1: Bar chart of Age Group distribution in study population (N=45)

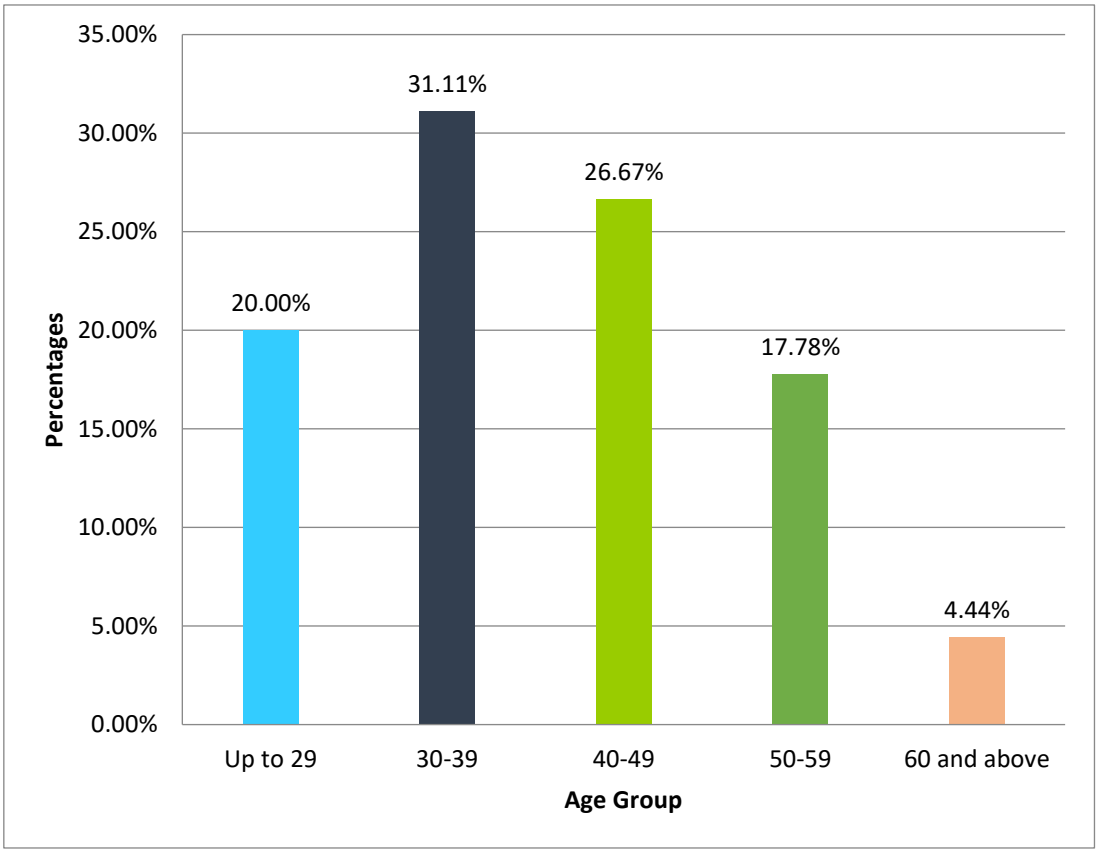


Fig 2: Bar chart of Gender distribution in study population

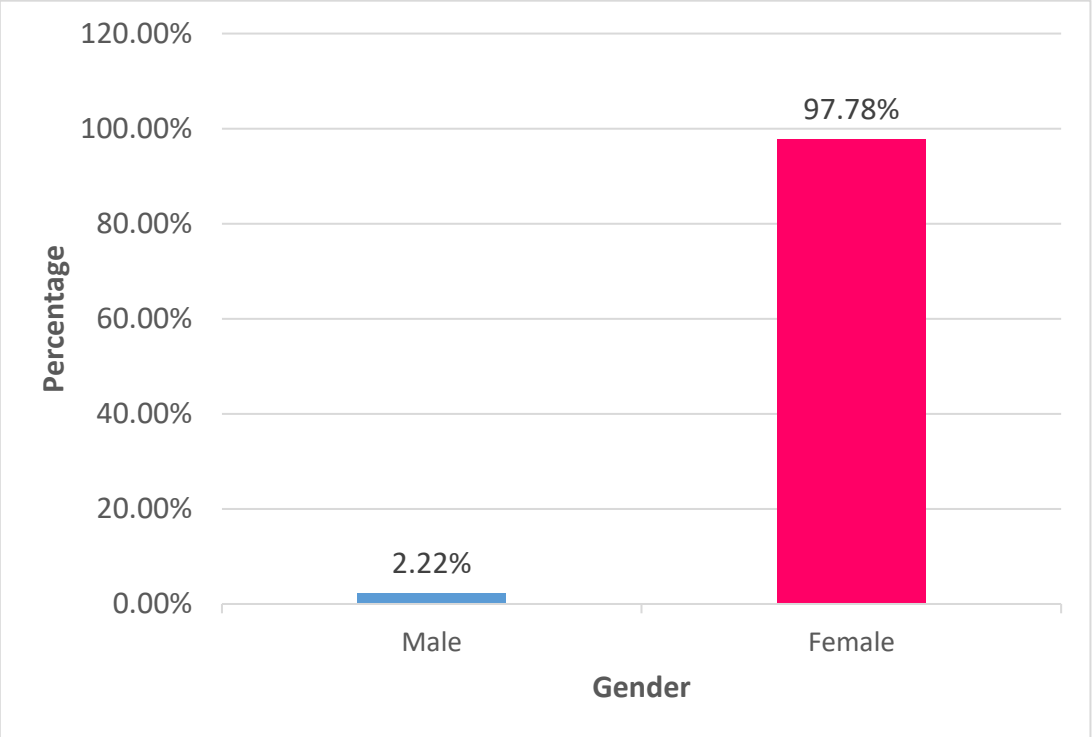


Table 4: Descriptive analysis of Right/Left in study population

(N=45)

Right/Left	Frequency	Percentages
LEFT	20	44.44%
RIGHT	19	42.22%
BOTH	6	13.33%

Fig 3: Pie chart of Right/Left distribution in study population (N=45)

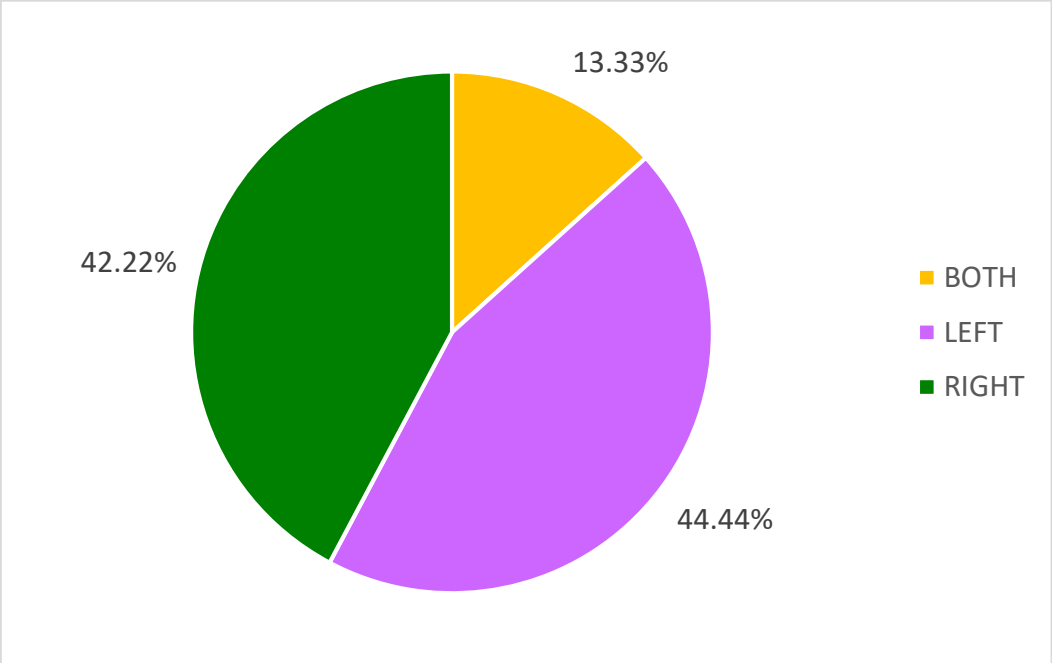


Table 5: Descriptive analysis of MRI curve in study population (N=45)

MRI curve	Frequency	Percentages
TYPE I	18	40.00%
TYPE II	9	20.00%
TYPE III	18	40.00%

Fig 4: Pie chart of MRI curve distribution in study population (N=45)

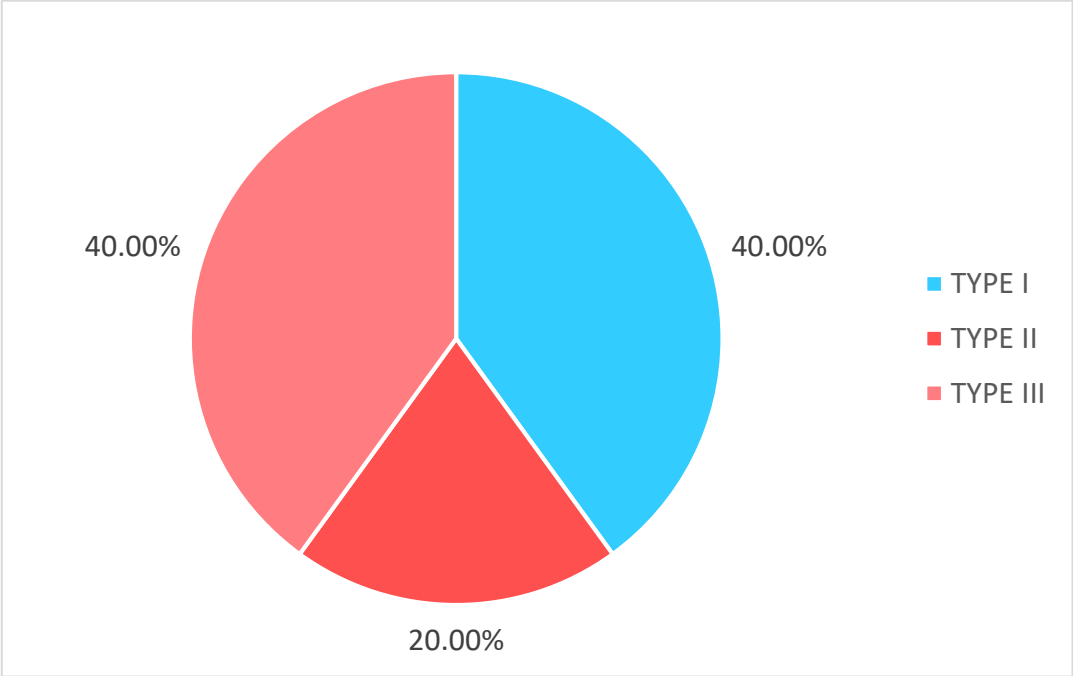


Table 6: Descriptive analysis of Sonoelastography Grade in study population (N=45)

Sonoelastography	Frequency	Percentage
Grade-2	12	26.67%
Grade-3	18	40.00%
Grade-4	12	26.67%
Grade-5	3	6.67%

Fig 5: Pie chart of Sonoelastography Grade distribution in study population (N=45)

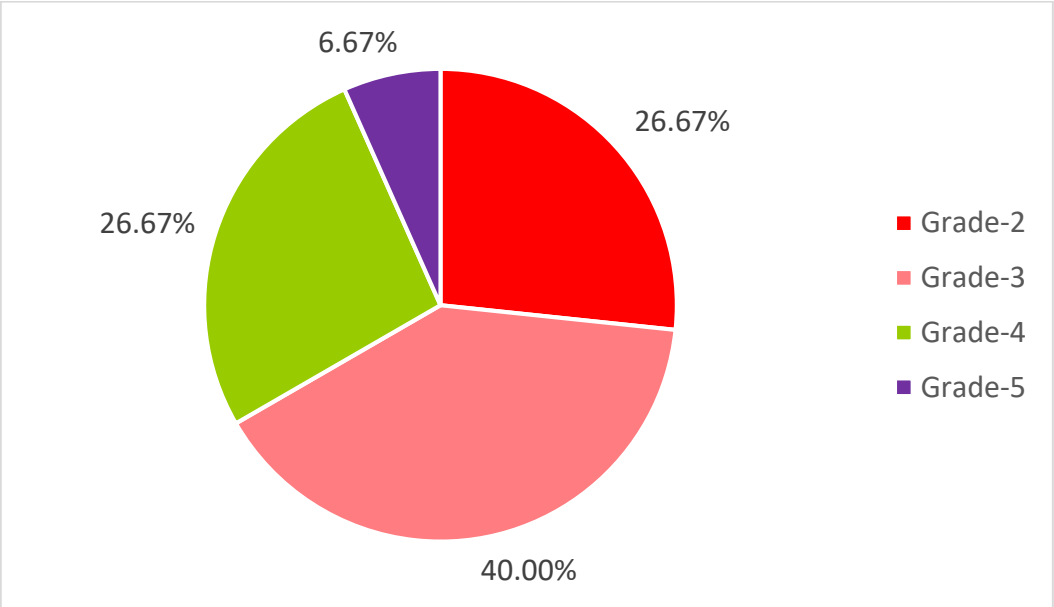


Table 7: Descriptive analysis of BIRADS in study population (N=45)

BIRADS	Frequency	Percentage
III	22	48.89%
IV	16	35.56%
V	6	13.33%
VI	1	2.22%

Fig 6: Pie chart of BIRADS distribution in study population (N=45)

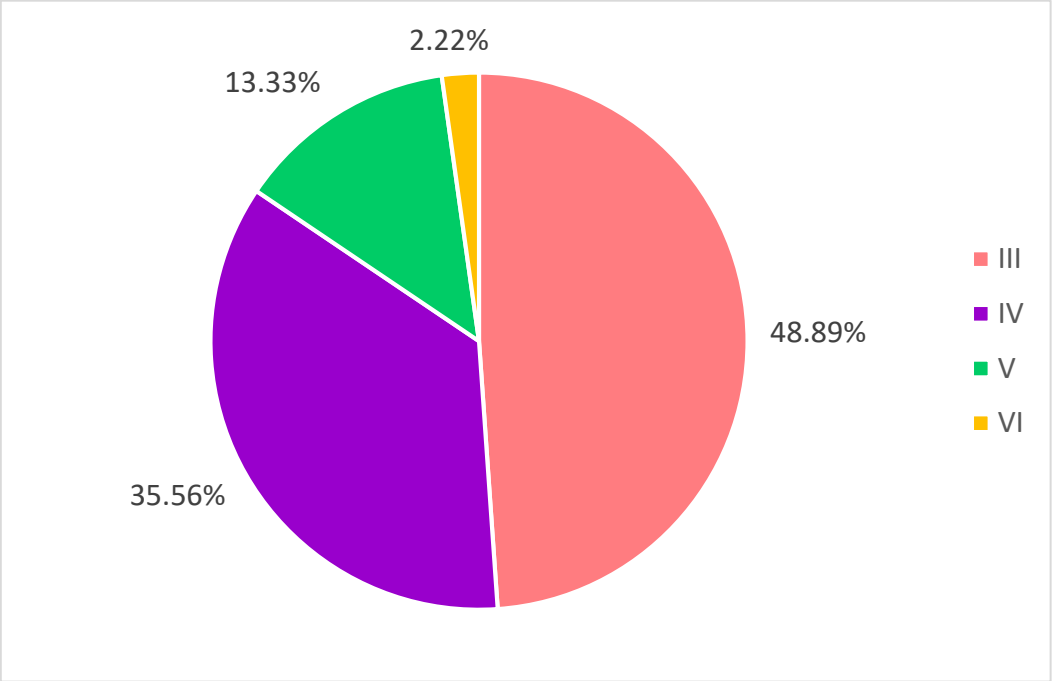


Table 8: Descriptive analysis of Final Histopathological Diagnosis (HPE) in study population (N=45)

Final Diagnosis(HPE)	Frequency	Percentage
Malignant	19	42.22%
Benign	26	57.78%

Fig 7: Bar chart of Final Histopathological Diagnosis (HPE) distribution in study population (N=45)

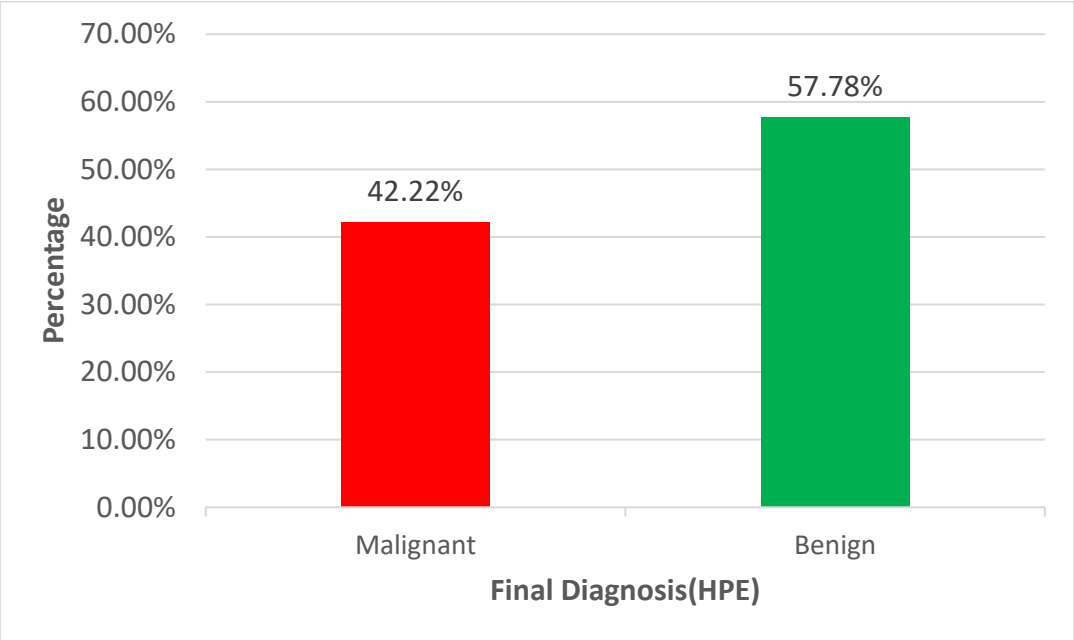


Table 9: Association of Final Histopathological Diagnosis (HPE) with dynamic MRI mammogram curve category of study population (N= 45)

MRI Curve category	Final Histopathological Diagnosis(HPE)		Chi square	P-value
	Malignant	Benign		
Malignant	17 (89.47%)	1 (3.85%)	33.537a	<0.001
Benign	2 (10.53%)	25 (96.15%)		

Table 10: Predictive validity of dynamic MRI mammogram curve category as compared Final Histopathological Diagnosis (HPE) (N=45)

Parameter	Value	95% CI	
		Lower	Upper
Sensitivity	89.5%	75.67%	100.0%
Specificity	96.2%	88.76%	100.0%
False positive rate	3.8%	1.00 %	11.2%
False negative rate	10.5%	1.00 %	24.3%
Positive predictive value	94.4%	83.86%	100.0%
Negative predictive value	92.6%	82.71%	100.0%
Diagnostic accuracy	93.3%	86.05%	100.0%

Reliability: (Kappa statistic)

	Kappa statistics	Std. Error	P-value
Measures of Agreement	0.862	0.077	<0.001

Positive likelihood ratio: -6.7

Negative likelihood ratio: 0.07

Table 11: Association of Final Histopathological Diagnosis (HPE) with sonoelastography Grade category of study population (N=45)

Sonoelastography Grade category	Final Histopathological Diagnosis(HPE)		Chi square	P-value
	Malignant	Benign		
Malignant	13 (68.42%)	2 (7.69%)	18.219a	<0.001
Benign	6 (31.58%)	24 (92.31%)		

Table 12: Predictive validity of Sonoelastography Grade category as compared Final Histopathological Diagnosis (HPE) (N=45)

Parameter	Value	95% CI	
		Lower	Upper
Sensitivity	68.4%	47.52%	89.3%
Specificity	92.3%	82.06%	100.0%
False positive rate	7.7%	1.00 %	17.9%
False negative rate	31.6%	10.68%	52.5%
Positive predictive value	86.7%	69.46%	100.0%
Negative predictive value	80.0%	65.69%	94.3%
Diagnostic accuracy	82.2%	71.05%	93.4%

Reliability: (Kappa statistic)

	Kappa statistics	Std. Error	P-value
Measures of Agreement	0.625	0.118	<0.001

Positive likelihood ratio: -23.9

Negative likelihood ratio: 0.26

Fig 8: Bar chart of HPE distribution in study population (N=45)

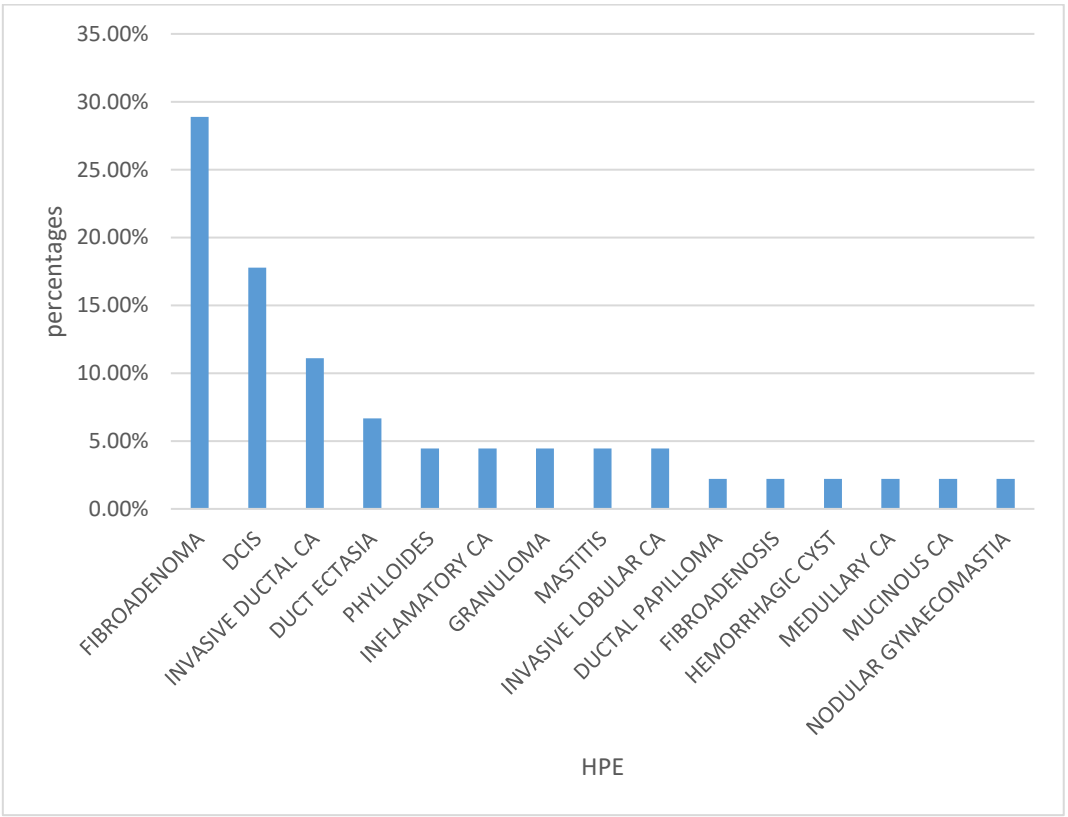
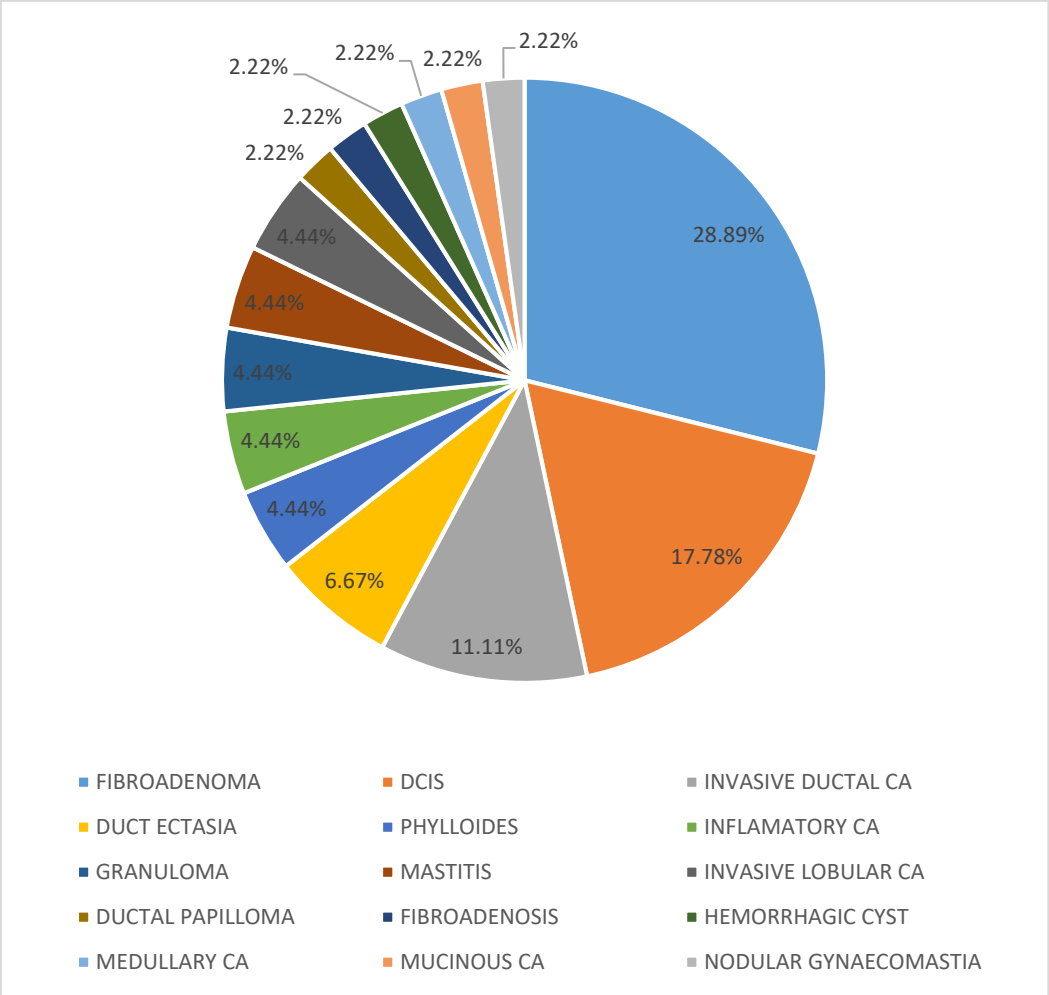


Table 13: Descriptive analysis of Histopathological Diagnosis in study population (N=45)

Histopathological Diagnosis	Frequency	Percent
Fibroadenoma	13	28.89%
Dcis- ductal carcinoma in situ	8	17.78%
Invasive ductal carcinoma	5	11.11%
Duct ectasia	3	6.67%
Phylloides	2	4.44%
Inflamatory carcinoma	2	4.44%
Granuloma	2	4.44%
Mastitis	2	4.44%
Invasive lobular carcinoma	2	4.44%
Ductal papilloma	1	2.22%
Fibroadenosis	1	2.22%
Hemorrhagic cyst	1	2.22%
Medullary carcinoma	1	2.22%
Mucinous carcinoma	1	2.22%
Nodular gynaecomastia	1	2.22%

Fig 9: Pie chart of HPE distribution in study population (N=45)



DISCUSSION

Our study consists of 45 cases. Among the study group, female were 97.88% and only one Male (2.22%) was included. (table 3 & figure 2).

The mean age of cases included in our study was 39.71 years with a standard deviation of 11.88. The youngest person was 21 years old and the oldest person was 74-years-old. (table1)**.** Majority (31.11%) subjects belonged to 30 to 39-years age group, followed by 40 to 49-years age group (26.67%). (Table 2 & figure 1).

This age statistics in our study is contemporary with the present trend in the incidence of breast cancer among Indian women which is in increasing numbers of female from 25 to 40 years of age as stated by **Sandhu et al** [46] and **Somdatta et al et al** [47]

Müller-Schimpfle et al [48] studied the correlation between age of the patient and contrast enhancement, demonstrated that contrast enhancement is better in patients aged 35–50 years than that in younger and older patients. Our study did not show any significant association between age of the patient and contrast enhancement.

Among the breast pathologies studied, pathologies are seen in the left breast in 44.44%, right breast in 42.22% and bilateral in 13.33%.

(Table 4 & figure 3). Similar to few previous studies [23,30,31] there is no statistical difference between incidence of malignant masses to the side of the breast affected.

Among the Final Diagnosis (HPE) of the studied breast pathologies, malignant lesions were noted in 42.22% and Benign lesions in 57.78% . (Table 8 & figure 7)

Fibroadenoma is the most commonly diagnosed benign breast mass and Invasive Ductal Carcinoma is the most common among the malignant masses as analysed by **Schoonjans JM et al** [1].

Similarly, among various histopathological diagnosis of breast masses included in this study, there were 13 cases (28.89%) of fibroadenomas, few were giant fibroadenoma and one case was with multiple fibroadenomas in inflammatory background which were misdiagnosed as malignant by imaging.

Among the malignant masses, the incidence of DCIS (Ductal Carcinoma In Situ) is high. There were 8 cases of DCIS and 5 cases of Invasive Ductal Carcinoma.

The other benign masses found in our study were 3 cases of duct ectasia, 2 cases of phylloides tumor, 2 cases of chronic mastitis, 2 cases

of granulomas, 1 case of intraductal benign papilloma, fibroadenosis and haemorrhagic cyst.

Among other malignant masses, 2 cases of Inflammatory and Invasive Lobular carcinoma, 1 case of Medullary and Mucinous carcinoma was found.

Among the Dynamic MRI Mammogram curves, Type I curve is noted in 40%, Type II in 20%, and Type III in 40%.(Table 5 & figure 4).

Sensitivity of evaluation of breast masses with BIRADS III and above categories by Dynamic MR Mammogram curve patterns is 89.5% (95 CI 75.67%_ 100%), and the specificity is 96.2% (95 CI 88.76%_ 100%) with Final Diagnosis by HPE as the gold standard.

With MR Mammogram, the sensitivity and specificity were ranging from 80% to 98% in studies by **Liu PF et al** [49] and **Mahfouz AE et al** [50] which is comparable to our study.

Delille JP et al and Dean KI et al [51,52] assessed the degree of changes in parenchymal enhancement in relation to patient's menstrual cycle. Study by **Marklund M et al** [53] assessed the effects of factors such as age, intake of hormone replacement therapy and oral contraceptives. The hormonal effects on contrast enhancement is not assessed in our study.

Positive predictive value of evaluation of breast masses with Dynamic MRI Mammogram curve categories is 94.4% (95 CI 83.86%_ 100%) and the negative predictive value is 92.6% (95 CI 82.71%_ 100%).

Among the study group, 17 cases (89.47%) with histologically proven malignant breast masses were diagnosed as malignant with MRI type III curve and 25cases (96.15%) with benign breast masses were also correctly interpreted with MR Mammogram.

False positive rate of evaluation of breast masses with Dynamic MRI Mammogram curve categories is 3.8% (95 CI 1.00%_ 11.2%) and the False negative rate is 10.5%(95 CI 1.00%-24.3%) with Final Diagnosis by HPE as the gold standard.

Only false positive case with MR Mammogram in our study is a case of multiple fibrodenomas in inflammatory background, in which all lesions had type III curve enhancement pattern.

Two false negative cases with MR Mammogram are two cases of ductal carcinoma in situ, in which tiny lesions had type II curve (intermediate) enhancement.

The diagnostic accuracy of evaluation of breast masses of BIRADS III and above categories with Dynamic MRI Mammogram curve patterns is 93.3% (95 CI 86.05%_ 100%). (table 10)

The comparision between Final Diagnosis of breast masses with HPE and Dynamic MR Mammogram curve analysis is statistically significant (P value <0.001). (Table 9)

In Sonoelastography Grading, the incidence of Grade-2 score is 26.67%, Grade-3 is 40%, Grade 4 is 26.67% and Grade -5 is 6.67% of the study population.(Table 6 & figure 5)

Among the BIRADS categories, BIRADS III is noted in 48.89%, IV in 35.56%, V in 13.33% and VI in 2.22%. (Table 7& figure 6)

Sensitivity of Sonoelastography Grading in evaluation of breast masses with BIRADS III and above categories is 68.4% (95 CI 47.52%_ 89.3%) and the specificity is 92.3% (95 CI 82.06%_ 100%).

Positive predictive value of Sonoelastography in evaluation of breast masses with BIRADS III and above categories is 86.7% (95 CI 69.46%_ 100%) and the Negative predictive value is 80% (95 CI 65.69%_ 94.3%).

Among our study group, 13(68.42%) cases of histopathologically proven malignancies were correctly diagnosed as malignant with

Sonoelastography Grades 4 and 5. 24(92.31%) cases of benign breast masses were correctly diagnosed with Sonoelastography Grades 2 and 3 as benign.

False positive rate of Sonoelastography in evaluation of breast masses with BIRADS III and above categories is 7.7% (95 CI 1.00%_ 17.9%) and the False negative rate is 31.6% (95 CI 10.68%_ 52.5%).

The male case presented with palpable nodule under the nipple. On B mode USG, BIRADS IV lesion seen, which had grade 4elastographic score. On Dynamic MR Mammogram, type I curve (benign) was obtained. The male breast mass was finally proven to be a case of nodular gynecomastia (benign).

2 cases (7.69%) with benign breast masses (one female with giant fibroadenoma and one male with nodular gynecomastia) were misdiagnosed as malignant by Sonoelastography. Presence of fibrotic components and undetected calcification on B mode USG are the potential causes of false positive Sonoelastography

The overall diagnostic accuracy of Sonoelastography in evaluation of breast masses with BIRADS III and above categories is 82.2% (95 CI 71.05%_93.4%). (Table 12)

The comparision of the Final Diagnosis between HPE and Sonoelastography Grades is statistically significant (P value <0.001). (Table 11)

Similar to the study by **Itoh et al** [23] on sonoelastography, the score 1or 2 indicated by homogenous strain pattern suggestive of soft nature / benign lesions, is not found in any of our cases proved to be malignant. It helps to avoid unnecessary invasive histological evaluation of these lesions.

In a study by **Raza et al** [54], 84% of malignant lesions were with elasticity scores 4 and 5. In our study 68.4% malignant masses were with elasticity scores 4 or 5 and 92.3% benign lesions had elasticity scores of 2 and 3.

In studies by **Thomas A et al and Lee JH et al** [55,56], the sensitivity of sonoelastography were ranging from 67% to 83% and specificity from 86.7% to 90%. Studies by suggested that addition of elastographic findings to conventional B mode USG can improve the sensitivity and specificity.

ElSaid NAet al [57] comparative study on sonoelastogram vs dynamic MR Mammogram on BIRADS III and above categories lesions had sensitivity of 84% for Sonoelastography and 88 % for MR

Mammogram. The study had specificity of 84% for Sonoelastography and 80 % for MR Mammogram.

Compared to previous studies [55,56,57], the specificity of Sonoelastography in diagnosing malignant breast masses is high in our study.

Sonoelastography is cheaper compared to MRI, but it is highly operator dependant.

Advantages of MR Mammogram includes its efficacy in evaluating the masses in dense breasts, has high image resolution, aids in evaluating the inverted nipples and is an noninvasive modality of imaging the ductal pathologies with an added advantage of imaging both breasts simultaneously. MR imaging is the choice of study in evaluation of augmented breasts with implants in situ.

Limitations of MR Mammogram are it is more expensive compared to Ultrasound and it is not good at detecting calcifications. Periovulatory hormonal changes have an influence over the contrast enhancement patterns in MR Mammogram.

CONCLUSION

Both sonoelastogram and MR mammogram are effective in characterising the malignant nature of the breast masses. Addition of elastography to conventional B mode USG aids in improved detection of breast masses.MRI is advantageous over Ultrasound in simultaneous diagnosis of multiple lesions in both breasts. Dynamic contrast MRI has an added advantage of early evaluation of in situ malignancies. Combination of both morphological and kinetic curve analysis has improved sensitivity and specificity of MR Mammogram.

Both Sonoelastography and MR Mammogram are efficient techniques to evaluate breast lesions and can potentially decrease the number of unnecessary biopsies.

In our study, both the sensitivity and specificity are high for MR Mammogram compared to Sonoelastography.

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PATIENT CONSENT FORM

STUDY DETAIL : **A comparative study on predictive value of malignancy in suspicious breast masses of BIRADS III & above categories using Sonoelastography and Dynamic MR Mammogram**

PATIENT'S NAME :
PATIENT'S AGE :
IDENTIFICATION NUMBER :

I confirm that I have understood the purpose and procedure of the above study.

I will be subjected to Sonoelastography and MR Mammmogram with contrast administration. I have the opportunity to ask questions and all my questions and doubts have been answered to my complete satisfaction.

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected.

I understand that the sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However I understand that my identity would not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study.

I hereby consent to participate in this study.

I hereby give permission to undergo complete clinical examination and diagnostic tests including haematological, biochemical and followed by radiological tests .

Patient’s signature/thumb impression:

Patient’s name and address:

Place: Date:

Signature of the investigator: Name of the investigator:

Place: Date:

ஆராய்ச்சி ஒப்புதல் கடிதம்

கீழ்ப்பாக்கம் மருத்துவக் கல்லூரி கதிர் இயக்கவியல் துறையில் பயிலும் முதுகலை மருத்துவர் ம.அலமேலு அவர்கள் மேற்கொள்ளும் (எம்.ஆர்.ஐ மற்றும் சோனோ எலாஸ்டோகிராம் ஆகிய பரிசோதனைகளை கொண்டு மார்பக கட்டியின் தன்மையே கண்டறியும் முறை) ஆய்வில் பங்குகொள்ள ..... ஆகிய நான் முழு மனதுடன் சம்மதிக்கிறேன்.

எனக்கு விளக்கப்பட்ட விஷயங்களை நான் புரிந்து கொண்டு நான் எனது சம்மதத்தைத் தெரிவிக்கிறேன்.

இந்த ஆராய்ச்சியில் பிறரின் நிர்ப்பந்தமின்றி என் சொந்த விருப்பத்தின் பேரில் தான் பங்கு பெறுகிறேன் மற்றும் நான் இந்த ஆராய்ச்சியிலிருந்து எந்நேரமும் பின்வாங்கலாம் என்பதையும் அதனால் எந்த பாதிப்பும் ஏற்படாது என்பதையும் நான் புரிந்து கொண்டேன்.

நான் என்னுடைய சுயநினைவுடன் மற்றும் முழு சுதந்திரத்துடன் இந்த மருத்துவ ஆராய்ச்சியில் என்னை சேர்ந்துக் கொள்ள சம்மதிக்கிறேன்.

எனது மார்பில் இருக்கும் கட்டியின் தன்மையினை கண்டறிய எம்.ஆர்.ஐ மற்றும் சோனோ எலாஸ்டோகிராம் ஆகிய பரிசோதனைகள் செய்யப்படும் முறைகள் பற்றி நன்கு அறிந்த பின்னரே, இந்த ஆய்வில் பங்கேற்க நான் முழுமனதுடன் சம்மதிக்கிறேன்.

பங்கேற்பாளர் கையொப்பம் ..... இடம் : ..... தேதி .....

பங்கேற்பாளர் பெயர் மற்றும் விலாசம் :

ஆராய்ச்சியாளர் கையொப்பம்.....இடம் : ..... தேதி .....

PROFORMA

NAME:

AGE:

SEX:

ADDRESS & PHONE NO:

EDUCATION:

GENERAL I.Q:

OCCUPATION TYPE – PROFESSIONAL / SEMI SKILLED / UNSKILLED (MANUAL WORKER)

MONTHLY INCOME:

PRESENTING COMPLAINTS:

HISTORY OF PREVIOUS SURGERIES:

HISTORY OF ANY MEDICATIONS:

MENSTRUAL AND OBSTETRIC HISTORY:

GENERAL EXAMINATION:

LOCAL EXAMINATION :

INSPECTION

PALPATION

B-MODE USG FINDINGS AND BIRADS:

SONOELASTOGRAPHY SCORING:

MRI MAMMOGRAM FINDINGS:

DYNAMIC CONTRAST MRI MAMMOGRAM CURVE TYPE:

PATIENT'S INFORMATION SHEET

Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to image the anatomy and the physiological processes of the body in both health and disease.MRI scanners use strong magnetic fields, radio waves, and field gradients to form images of our body.

During the scan, you lie on a table that slides inside a tunnel-shaped machine. Doing the scan can take a long time from 30 minutes to 60 minutes. The scan is painless. The MRI machine makes a lot of noise.

The powerful magnetic field of the scanner can attract certain metallic objects known as ''ferromagnetic'' objects, causing them to move suddenly and with great force towards the center of the MR system. Therefore, great care is taken to prevent Ferromagnetic objects from entering the MR system room. It is vital tom remove metallic objects in advance of an MRI exam, including watches, jewellery, and items of clothing that have metallic threads or fasteners.

A contrast agent called ''gadolinium'' may be injected into a vein to help obtain a clearer picture of the area being examined. This is typically done through a small needle connected to an intravenous line that is placed in arm or hand vein. MRI contrast agents do not contain iodine and therefore, rarely cause allergic reactions or other problems.

MRI Mammogram is done to characterise the breast lesion in detail. It has nil hazards. MRI Mammogram is of great value in breast masses characterisation.

Sonoelastography is a new technique of ultrasound detecting the elasticity of tissues. Since it is use of ultrasound waves, has no ionization hazards. It is less time consuming. It is noninvasive.

You will be first subjected to sonoelastogram and MR Mammogram to characterise your breast pathology and followed by FNAC / Biopsy correlation.

INSTITUTIONAL ETHICS COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE, CHENNAI-10

Ref.No.4721/ME-1/Ethics/2016 Dt: 11.08.2016

CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval **"A comparative study on predictive value of malignancy in suspicious breast masses of birads III & above categories using sonoelastography and dynamic MR mammogram."** – For Project Work Submitted by Dr.M.Alamelu .MD, Dept. of Radio Diagnosis, Govt. KMC, Chennai-10.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information / informed consent and asks to be provided a copy of the final report.

19/8/16.

DEAN
Ethical Committee
Govt.Kilpauk Medical College,
Chennai

My Comp<E Colon< ME 1 Sec> Ethical Committee

19/8/16

ABBREVIATIONS

1. BI-RADS- Breast Imaging-Reporting and Data System
2. USG-ultrasonography
3. MRI- magnetic resonance imaging
4. TDLU- Terminal ductal lobular unit
5. TNBC- triple-negative breast carcinoma
6. BMI- body mass index
7. ARFI- acoustic radiation force impulse
8. RSV-Real-time shear velocity
9. AUC- Area under the curve
10. DCIS-Ductal carcinoma in situ
11. LCIS-Lobular carcinoma in situ
12. HMW-high molecular weight
13. ILC-Invasive lobular carcinoma
14. IDC-Invasive Ductal carcinoma
15. IBC-Inflammatory Breast Cancer
16. FNAC- Fine Needle aspiration biopsy
17. VABB -Vacuum-assisted breast biopsy
18. STIR- short tau inversion recovery
19. HPE-Histopathological examination
20. CI-Confidence IntervaI

URKUND

Urkund Analysis Result

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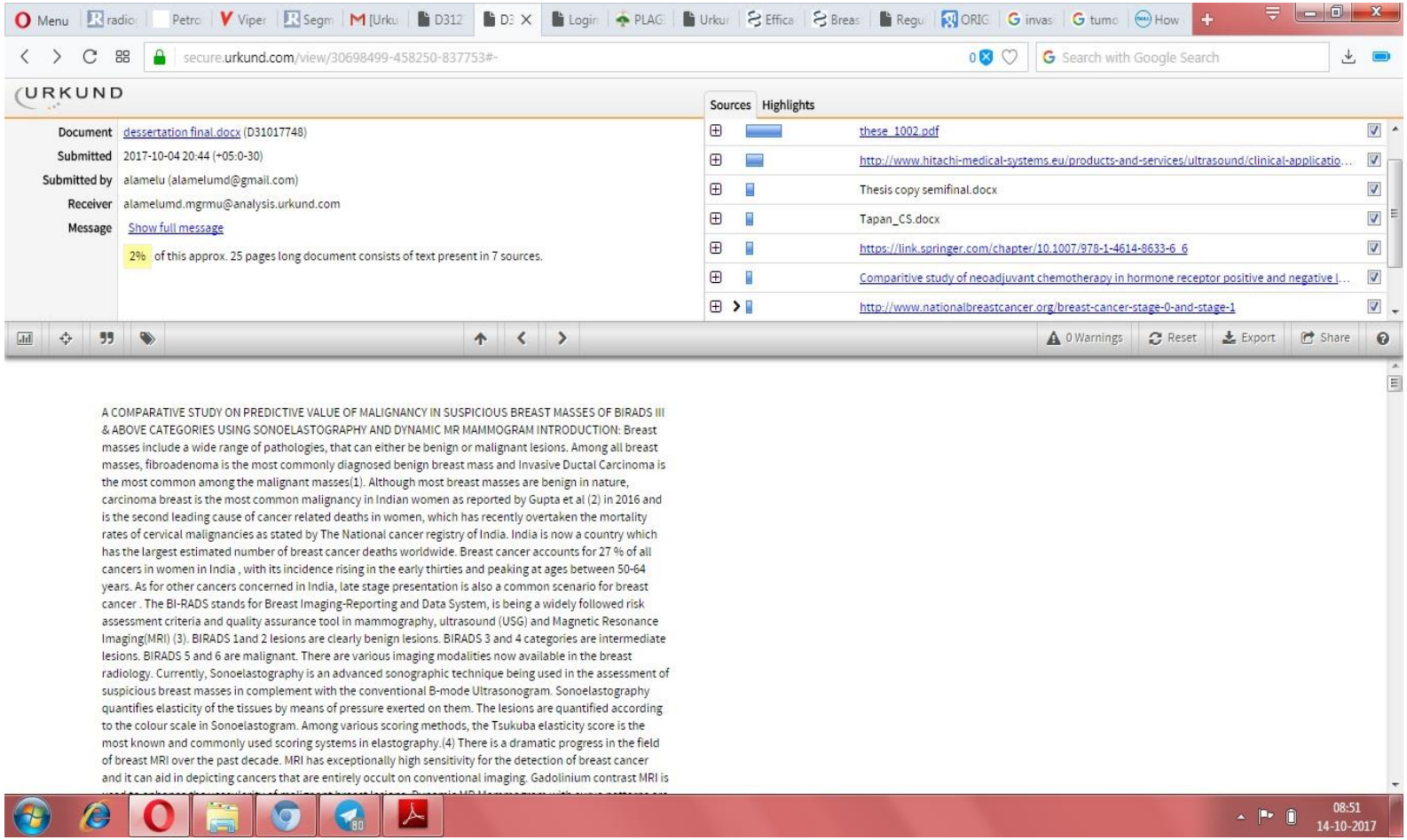
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A COMPARATIVE STUDY ON PREDICTIVE VALUE OF MALIGNANCY IN SUSPICIOUS BREAST MASSES OF BIRADS III & ABOVE CATEGORIES USING SONOELASTOGRAPHY AND DYNAMIC MR MAMMOGRAM INTRODUCTION: Breast masses include a wide range of pathologies, that can either be benign or malignant lesions. Among all breast masses, fibroadenoma is the most commonly diagnosed benign breast mass and Invasive Ductal Carcinoma is the most common among the malignant masses(1). Although most breast masses are benign in nature, carcinoma breast is the most common malignancy in Indian women as reported by Gupta et al (2) in 2016 and is the second leading cause of cancer related deaths in women, which has recently overtaken the mortality rates of cervical malignancies as stated by The National cancer registry of India. India is now a country which has the largest estimated number of breast cancer deaths worldwide. Breast cancer accounts for 27 % of all cancers in women in India , with its incidence rising in the early thirties and peaking at ages between 50-64 years. As for other cancers concerned in India, late stage presentation is also a common scenario for breast cancer . The BI-RADS stands for Breast Imaging-Reporting and Data System, is being a widely followed risk assessment criteria and quality assurance tool in mammography, ultrasound (USG) and Magnetic Resonance Imaging(MRI) (3). BIRADS 1and 2 lesions are clearly benign lesions. BIRADS 3 and 4 categories are intermediate lesions. BIRADS 5 and 6 are malignant. There are various imaging modalities now available in the breast radiology. Currently, Sonoelastography is an advanced sonographic technique being used in the assessment of suspicious breast masses in complement with the conventional B-mode Ultrasonogram. Sonoelastography quantifies elasticity of the tissues by means of pressure exerted on them. The lesions are quantified according to the colour scale in Sonoelastogram. Among various scoring methods, the Tsukuba elasticity score is the most known and commonly used scoring systems in elastography.(4) There is a dramatic progress in the field of breast MRI over the past decade. MRI has exceptionally high sensitivity for the detection of breast cancer and it can aid in depicting cancers that are entirely occult on conventional imaging. Gadolinium contrast MRI is
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S. NO	MRI ID NO.	NAME	AGE /SEX	RIGHT/LEFT	MRI CURVE	USG ELASTOGRAM GRADE	BIRADS	HPE	BENIGN =1, MALIGNANT = 2
1	1707	SANDHIYA	21/F	BOTH	TYPE III	2 &3	IV	FIBROADENOMAS IN INFLAMMATORY BACKGROUND	1
2	1341	AMALA	29/F	RIGHT	TYPE II	2	III	MASTITIS	1
3	3375	AMUDHA RAMESH	40/F	LEFT	TYPE I	2	IV	GRANULOMA	1
4	2145	ANJALATCHI	58/F	LEFT	TYPE II	3	III	DCIS	2
5	2567	BHAVANI	37/F	RIGHT	TYPE III	4	V	MEDULLARY CA	2
6	2159	DEVAGI	74/F	LEFT	TYPE III	4	VI	INVASIVE DUCTAL CA	2
7	3574	SORNAM	56/F	BOTH	TYPE I	3	III	FIBROADENOMA	1
8	1631	SRIDEVI	40/F	RIGHT	TYPE I	2	III	FIBROADENOMA	1
9	2208	IDAYATHISHA	65/F	LEFT	TYPE III	5	V	INVASIVE DUCTAL CA	2
10	90	JAYASHREE	40/F	LEFT	TYPE II	3	III	FIBROADENOMA	1
11	265	KANAGAVALLI	55/F	RIGHT	TYPE III	4	IV	DCIS	2
12	3451	KASIAMMAL	55/F	LEFT	TYPE III	4	V	INVASIVE LOBULAR CA	2
13	3313	MOHANA	40/F	LEFT	TYPE I	2	III	DUCT ECTASIA	1
14	2446	PARVATHY	48/F	RIGHT	TYPE I	3	III	GRANULOMA	1
15	1756	PUNITHAVALLI	46/F	BOTH	TYPE II	2	III	FIBROADENOMA	1
16	1847	RANI	50/F	LEFT	TYPE III	3	IV	DCIS	2
17	254	SANDHYA	22/F	BOTH	TYPE II	3	III	MULTIPLE FIBROADENOMAS	1
18	2129	SANGEETHA	37/F	BOTH	TYPE I	2	III	FIBROADENOMAS	1
19	1220	SHANTHI	45/F	RIGHT	TYPE III	4	IV	DCIS	2
20	3178	SUNIL KUMAR	21/M	LEFT	TYPE I	4	IV	NODULAR GYNAECOMASTIA	1
21	3626	TAMILARASI	40/F	BOTH	TYPE I	3	III	HEMORRHAGIC CYST	1
22	2179	THULASIMALA	55/F	LEFT	TYPE I	3	IV	FIBROADENOMA	1

23	1035	VANITHA	44/F	RIGHT	TYPE I	3	III	FIBROADENOMA	1
24	3172	VIMALA	32/F	LEFT	TYPE I	2	III	MASTITIS	1
25	1399	NISHANTHI	26 F	RIGHT	TYPE I	2	III	FIBROADENOSIS	1
26	1437	GAYATHRI	31 F	RIGHT	TYPE I	3	III	DUCT ECTASIA	1
27	940	MARIA	40 F	LEFT	TYPE II	2	III	FIBROADENOMA	1
28	1033	CHITRA	37 F	LEFT	TYPE II	3	IV	DCIS	2
29	3111	REVATHY	28F	LEFT	TYPE II	3	IV	PHYLLOIDES	1
30	586	SUGITHA	32F	RIGHT	TYPE III	5	V	INVASIVE DUCTAL CA	2
31	1033	CHITRA	37 F	RIGHT	TYPE II	3	III	DUCT ECTASIA	1
32	999	PAVALAM	41F	RIGHT	TYPE I	2	III	FIBROADENOMA	1
33	1102	MARY	54F	LEFT	TYPE I	2	III	PHYLLOIDES	1
34	80	JANAKI	33F	RIGHT	TYPE I	4	IV	GIANT FIBROADENOMA	1
35	564	VINIYHA	32F	LEFT	TYPE III	3	IV	DCIS	2
36	654	VIDHYA	52F	RIGHT	TYPE III	4	III	INFLAMATORY CA	2
37	323	BEGUM	25F	RIGHT	TYPE III	4	IV	INVASIVE DUCTAL CA	2
38	213	GHEETHA	27F	LEFT	TYPE III	3	III	DCIS	2
39	1103	JANAKI	33F	RIGHT	TYPE III	4	IV	INVASIVE LOBULAR CA	2
40	231	ANNALAKSHMI	44F	RIGHT	TYPE I	3	III	GIANT FIBROADENOMA	1
41	956	CHITRA	35F	LEFT	TYPE III	3	IV	DCIS	2
42	556	NITHYA	36F	RIGHT	TYPE III	4	V	INFLAMATORY CA	2
43	456	HEMA	29F	RIGHT	TYPE III	4	IV	INVASIVE DUCTAL CA	2
44	133	SENTHAMARAI	32F	LEFT	TYPE III	5	V	MUCINOUS CA	2
45	651	KALAVATHY	33F	LEFT	TYPE I	2	IV	DUCTAL PAPILLOMA	1